# THE MIXOGRAPH HANDBOOK

## First Edition

Compiled and Edited by
**C. E. (Chuck) Walker, J. L. Hazelton, and M. D. Shogren**

**Kansas State University**
**Manhattan, KS**
**1997**

Published by
**National Manufacturing Division, TMCO**
507 “J” St.
Lincoln, NE 68508-2935 USA

Cover graphic is a sample output from the MixSmart software, available from:
National Manufacturing Division, TMCO

Copyright 1997 by National Manufacturing Division, TMCO

All right reserved. No part of this work covered by the copyright hereon may be reproduced or used in any form by any means - graphic, electronic, or mechanical, including photocopying, recording, taping, or information storage and retrieval systems - without written permission of the publisher.

Printed in U.S.A.

National Manufacturing Division, TMCO
507 “J” St.
Lincoln, NE 68508-2935
U.S.A.

## About the Editors

Chuck Walker is Professor of Bakery Science and Management, Department of Grain Science and Industry at Kansas State University. He received his B.S. in Chemical Engineering from Iowa State University and his Ph.D. in Cereal Chemistry from North Dakota State University. Prior to joining KSU in 1988, he was Professor of Food Science and Technology at the University of Nebraska, Lincoln where he developed courses and a research program in Cereal Science and Technology. Chuck also worked at Fairmont Foods Co., General Mills, and Valley City State College. He is past chair of the AACC Physical Testing Methods Technical Committee, and has authored or co-authored over 100 technical publications.

Janet Hazelton is a research associate with the Department of Grain Science and Industry at Kansas State University. She received her B.S. in Foods and Nutrition and her M.S. in Grain Science, both from Kansas State University. The emphasis of her work at KSU is in applied rheology using both the Mixograph and Rapid Visco Analyser. She has been an active member in the National and the Manhattan Section of the AACC, and has authored or co-authored over 20 technical publications.

Merle Shogren retired from the USDA-ARS Grain Quality and Structure Research Unit (Hard Winter Wheat Laboratory), USDA Grain Production, Marketing, and Research Center in 1988 after 35 years service. He devoted his career to research on the factors responsible for and affecting breadmaking qualities of hard winter wheats and the selection of wheat breeders' experimental cultivars suitable for commercial white pan bread production. He has since been retained on a part-time basis through the Department of Grain Science and Industry, Kansas State University, as a consultant to the Grain Quality Structure Unit and to the Engineering Research Unit, both of the USDA -GPMRC, Manhattan, Kansas.

# DEDICATION TO DR. C. O. SWANSON

By G. W. Schiller

I first met Dr. C. O. Swanson in the fall of 1938. After a year of study in the field of Industrial Chemistry, I was discouraged and ready for a change. A friend recommended the Milling Department in the Agricultural School. There I met Dr. Swanson.

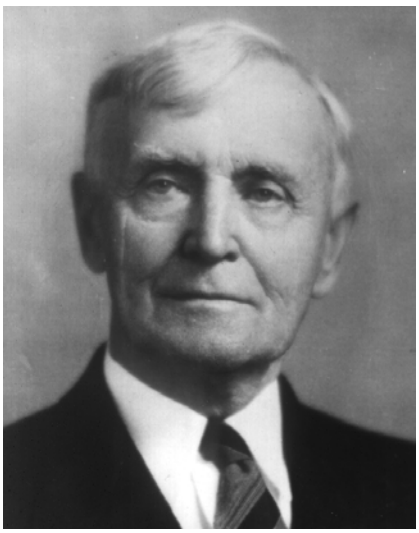
He was not a particularly impressive individual. His once blond, but now graying, hair and his blue eyes portrayed his Swedish background. Although he was approaching seventy years of age, he was an energetic and tireless person with a keen inquiring mind. He was somewhat less than a dynamic instructor. His manner was quiet, yet determined. He spoke in a soft voice and tended to write his thoughts on the blackboard in small letters. But his lectures were filled with challenges to his students.

Dr. Swanson not only taught the courses, he wrote the textbooks. He had just finished the book entitled *Wheat and Flour Quality* and it was our textbook for the course. In it he described many of his scientific studies. The work that caught my attention was his study of the effects of fertilization on the quality of wheat. He had gathered wheat samples from fields that had been pastured by cattle. Samples from within the cattle urination spots were compared to wheat samples gathered from around the spots. The results were conclusive that fertilization had a substantial effect upon the wheat quality. The study was often referred to as "In the Spots and Around the Spots."

We were introduced to the Swanson-Working Recording Dough Mixer. The story I heard was that Dr. Swanson attended the State Fair and there he observed a taffy making machine stretching taffy. He reasoned that if he could turn the taffy puller on end and attach a bowl to contain the dough then he could measure the development of the dough. With the help of Dr. Earl Working, he built the first recording dough mixer.

Although Dr. Swanson wrote many scientific articles and designed other pieces of equipment, it was the recording dough mixer that opened many investigative doors in the cereal chemistry field. After patents were complete, Mr. Walton Ferris of Lincoln, NE was commissioned to produce what was finally called the Mixograph. It became the backbone of dough rheology for the next half century.

It seems only fitting that the authors of this book dedicate it to the memory of Dr. C. O. Swanson.



C. O. Swanson

## Walt Ferris, the Man Behind National Manufacturing

By P. J. Mattern

The story of Walton Cutler Ferris Sr. is also the story of the National Manufacturing Co. A 1915 graduate of the University of Nebraska's School of Agriculture, Walt became a major influence in the Cereal Technology community through his manufacture and promotion of several pieces of laboratory test equipment still used today, more than 50 years after their introduction.

Cereal Laboratory equipment was an important sideline for many years. Ideas for equipment came from many cereal chemists. Prominent among them were Swanson and Working, Kansas State University; Sandstedt, University of Nebraska; and Finney and Shogren of the USDA, HRWW Quality Laboratory, Manhattan, KS.

Equipment items included the Mixograph, 200g and 100g dough mixers, fermentation cabinets, several models of test baking ovens, including a small reel design, and a set of small dough sheeting rolls and a 3-roll molder suitable for pup loaves. Equipment for chemical determinations were also developed including a horizontal revolving oven (moisture), various water baths and a test tube rack (diastatic activity of $\alpha$-amylase).

Dr. John Shellenberger (KSU) suggested that an "Award of Recognition" be given to Walton C. Ferris for his lifetime of effort on behalf of cereal chemists. The award was approved and the AACC made the presentation at the annual meeting in New Orleans October 5-8, 1976. The award that was given to him in recognition of, and appreciation for, his contributions to the design and development of cereal laboratory equipment.

## EDITOR'S POST SCRIPT

There is no question but that the inventors Swanson and Working deserve proper recognition for the Mixograph's original conception and development. Through a series of preliminary models, they demonstrated the instrument's value to the cereal chemistry profession, especially as a tool for the wheat breeder. Likewise, Mr. George Ferris deserves credit for reducing the Swanson-Working prototypes into a commercially viable instrument, the first National 35-gram Mixograph. Their work was essential for what was to come.

However, it was principally Mr. Karl Finney who, over nearly half a century, by his meticulous research work, extensive publishing, and teaching, gave the Mixograph the respectability and discipline that it so richly deserved. The entire cereal chemistry profession, and especially the North American wheat breeder, owes a debt of immense gratitude to Mr. Finney for his promotion and refinement of mixograph methodology and standardized baking tests. This contribution was formally recognized when a high quality Hard Red Winter Wheat was released by the Kansas Agricultural Experiment Station and named Karl in his honor.

It is only fitting that this "Mixograph Handbook" should also recognize the man who most promoted its use, Karl Frederick Finney.

C. E. Walker
Manhattan, KS
December, 1997

Karl Finney

# THE MIXOGRAPH HANDBOOK

## TABLE OF CONTENTS

About the Editors……iv
Dedication to C. O. Swanson……..v
Walt Ferris, the Man Behind National Manufacturing ..... vi
*P. J. Mattern*
Editor's Post Script ..... vii
Preface…. .....x
Contributors ..... xi
Acknowledgements..... xii

## HISTORY AND JUSTIFICATION

1. A Short History of the Mixograph.....1
*M. D. Shogren*

2. Comparison of Two Recording Dough Mixers: The Mixograph and Farinograph .....5
*M. E. Ingelin*

## METHODOLOGY

3. Operating Instructions for the 10- and 35gram Mixograph.....13
*M. D. Shogren*

4. The 2-g Direct Drive Mixograph.....17
*C. E. Walker and J. L. Hazelton*

5. Factors Influencing the Mixogram .....19
*K. F. Finney*

6. Mixogram Measurements and Objective Absorption Determination .....27
*J. L. Hazelton and C. E. Walker*

7. Measuring Dough Temperature Change and its Effects on Mixograms.....29
*K. Shelke, A. Li, J. L. Hazelton, and C. E. Walker*

8. Mixograph Pin Paths and Points of Minimum Clearance.....33
*C. E. Walker and J. L. Hazelton*

9. Computerizing the Mixograph: Data Collection and Analysis.....39
*C. E. Walker, A. E. Walker, and J. L. Hazelton*

10. Changing Mixogram Appearance by Sampling at Synchronized Head Pin Positions.....45
*J. L. Hazelton, C. E. Walker, and A. E. Walker*

11. Comparing Calibrations.....51

## MIXOGRAPH APPLICATIONS

12. Effects of Baking Ingredients and Additives on Mixograms ..... 55
*J. G. Ponte, Jr. and M. E. Ingelin*

13. A Rapid Check for Vital Gluten Quality ..... 63
*K. Neufeld and C. E. Walker*

14. Application of the Mixograph in the Evaluation of Wheat Used for Pasta ..... 65
*W. J. Pitz*

15. Assessment of Drying Damage to Hard Wheats ..... 67
*K. R. Preston*

16. Mixograph use at the U.S. Western Wheat Quality Laboratory ..... 69
*G. L. Rubenthaler*

17. Use of the Mixogram for Better Management Wheat Selection Decision ..... 71
*R. M. Pudden*

18. Quality Screening Using the Mixograph in Canada ..... 73
*O. M. Lukow*

19. The Mixograph in Europe ..... 75
*D. Weipert*

## APPENDICES

I. Mixograph References ..... 83

II. Mixograph Method: AACC Approved Method 54-40A ..... 97

III. Tables for Moisture Corrected Weights
A) 2g Mixograph ..... 101
B) 10g Mixograph ..... 109
C) 35g Mixograph ..... 117

IV. Reprint: 1972 Bakers Digest 46(2):32.
A Ten Gram Mixograph for Determining and Predicting Functional
Properties of Wheat Flours ..... 125
*K. F. Finney and M. D. Shogren*

V. Reprint: 1994 National Notes 1(3):13.
Walt, the Story of National Manufacturing ..... 137
*P. J. Mattern*

# PREFACE

After more than half a century, the Mixograph is still a viable and robust instrument, but no handbook has been published. It is firmly established in many bakeries, mills, and laboratories around the world where it is used for grain and flour quality checks, process quality control, and research. The 1989 AACC Annual Meeting symposium on the Mixograph highlighted its history, applications, new developments, and potentials. Many of those papers were published separately, in Cereal Foods World.

This handbook represents a collection of information on the origin, theory, and applications of the Mixograph. We have also included a substantial amount of information on the newer modifications, including computerization and data acquisition, for both the moving- and fixed-bowl design, and on the new 2-gram direct drive model. We have also included some practical information, including operating instructions, standard methods, moisture adjustment tables, and other items.

C. E. Walker
Past Chair, AACC Physical Testing Methods Committee
Manhattan, KS USA
December 1997

# CONTRIBUTORS

**K. F. Finney**, USDA - GPMRC, Ret., and Dept. of Grain Science and Industry, Kansas State University, Emeritus, Manhattan, KS, USA.

**J. L. Hazelton**, Dept. Of Grain Science and Industry, Kansas State University, Manhattan, KS, USA.

**M. E. Ingelin**, Agriculture Canada Winnipeg Research Station, Winnipeg, MB, Canada.

**A. Li**, The James Skinner Baking Company, Omaha, NE. USA.

**O. M. Lukow**, Agriculture Canada Winnipeg Research Station, Winnipeg, MB, Canada.

**P. J. Mattern**, Dept. of Agronomy, University of Nebraska, Emeritus and Retired Director of the Wheat Quality Laboratory, Lincoln, NE, USA

**K. Neufeld**, 2004 Avanti Dr., Grain Valley, MO. USA.

**W. J. Pitz**, Dept. of Cereal Science and Food Tech., North Dakota State University, Fargo, ND, USA.

**J. G. Ponte**, Dept. of Grain Science and Industry, Kansas State University, Emeritus, Manhattan, KS, USA.

**K. R. Preston**, Canadian Grain Commission, Winnipeg, MB, Canada.

**R. M. Pudden**, Dept. of Grain Science and Industry, Kansas State University, Emeritus, Manhattan, KS, USA.

**G. L. Rubenthaler**, USDA - WWQL, Ret., Pullman, WA, USA.

**G. W. Schiller**, Retired, 2101 S. Elizabeth, #602, Wichita, KS, USA.

**K. Shelke**, Ben & Jerry's, S. Burlington, VT. USA.

**M. D. Shogren**, USDA - GPMRC, Ret., Manhattan, KS, USA.

**A. E. Walker**, AEW Consulting, Lincoln, NE, USA.

**C. E. Walker**, Dept. of Grain Science and Industry, Kansas State University, Manhattan, KS, USA.

**D. Weipert**, Federal Center for Cereal, Potato, and Lipid Research, Detmold, Germany.

# ACKNOWLEDGMENTS

Extensive Contributions were made by Dr. Anthea Wooding during her graduate student days and Ms. Janet Hazelton, Research Assistant in the Department of Grain Science and Industry. Most of the materials on the configurations and on the 2-gram Mixograph were derived from Ms. Hazelton's 1994 MS thesis. The editors also acknowledge with gratitude the work by Ms. Chelse Groskop, Ms. Carolyn Chrest, and Ms. Lori Walker in assembling, coordinating, and preparing the final camera-ready copy. Without their capable assistance, this book could never have been completed.

# HISTORY AND JUSTIFICATION

# Chapter 1
# A SHORT HISTORY OF THE MIXOGRAPH

M. D. Shogren

USDA – GPMRC, Ret., Manhattan, KS, USA
Reprinted with permission form Cereal Foods World 35(5):480-482

As early as the 1870s, scientists were concerned with crop improvement, including the milling and baking qualities of a then-new winter wheat crop. Since Turkey was not so much a wheat variety as it was a type, improvement was accomplished by the selection of strains from it. Kansas State University had field trials by 1881 and Nebraska by 1890. In 1905, the Department of Chemistry at Kansas State University installed an experimental mill (in the corner of a chemistry laboratory) to begin evaluating the milling quality of new strains of hard winter wheat (Swanson 1929). By 1910, a separate department was required, and the Department of Milling Industries was established. Its goals were to promote the use and improve the quality and handling of Turkey-type wheats (Swanson 1929).

The head of the new department, Dr. C.O. Swanson, studied and reported on the recording dough mixers then in use. He recognized that hard winter and hard spring wheat flours had physical dough properties different from those of other classes of wheat. He knew that Canadian wheat and flours as well as those from the Plains area of the United States were high in protein and classed as strong.

The Farinograph mixer corresponds somewhat to that of European commercial bakery mixers. The action in an American bakery mixer is that of pull-fold-repull, and dough receives much more vigorous treatment than in European models. Criticisms of the Farinograph in testing strong wheats and flours are primarily due to not recognizing the original plan or the basis upon which the instrument was designed and built. The Chopin extensimeter also has a similar background in design and engineering (Swanson 1943)."

Swanson attempted (but had difficulties with) emulation of the actions of high-speed commercial mixers being used in America. Mixing small doughs with just moving pins resulted in portions riding around on the pins, whereas in large doughs, the sheer weight of dough provides the necessary holding or pull-back of the dough against the mixing arms (Swanson 1943). A commercial dough mixer representative of the type described by Swanson is illustrated in Figure 1, with the horizontal mixing arms being shown schematically in Figure 2. How the horizontal mixer is visualized is illustrated in Figure 3, with the arms pushing into and pulling out of the dough (shaded area).

However, the real suggestion came to Swanson during a trip with his wife to a movie (Schiller 1988). In the confectionery shop at the theater, he observed the construction (Fig. 4) and action (Fig. 5) of a taffy puller (Swanson 1943). The latter figure does bring to mind the appearance of a flour dough in the process of being mixed.

Swanson and Dr. E. B. Working then designed and built a planetary dough mixer in 1926 (Swanson and Working 1926). Those who knew both researchers say that Working was the mechanical genius. Early literature suggest that their original mixer had four revolving planetary pins and a 40-in. steel rod to indicate dough stiffness, but no bowl pins. Lack of the latter created a problem in that the dough could simply ride on the moving pins. The problem was solved by placing three fixed pins in the bottom of the bowl, thus precluding the use of the fixed steel rod for indicating dough stiffness (Swanson and Working 1933).

There may be a contradiction in the literature, since Swanson and Working had earlier described their first mixer as having three bowl pins (Swanson and Working 1926). Two pairs of moving pins revolved about a center point, while the two pins of each pair revolved about their respective centers. The path traced by a single revolving pin described an epitroichoid. The ratio of outer to center gears determined the path of the pins. As one pair was straddling; the other was hurdling a fixed pin. The numbers of stationary bowl pins were two, three, or four depending on the model and application, with the final number being three.

A third mixer having four bowl pins was constructed, with which they attempted to measure the reactions of different flours during mixing by means of a wattmeter. This proved to be unsuccessful because total energy input was measured; also, direct current was stated to have a damping effect while alternating current resulted in a continuously irregular curve (Swanson and Working 1933). However, from a diagram of the path of the moving pins (Fig. 6), they deduced that there could be a small amount of twist of the bowl without appreciably changing the relation of the fixed to the moving pins (Swanson and Working 1933). Eventually, this led to the Mixograph system with the rotating bowl and recording pen arm as we know it today.

A fourth mixer, employing the "twist-in-a-rod" principle, was constructed. As illustrated in Figure 7, it was big, cumbersome, and expensive. The wheel shown was from an automobile, giving one the idea of its size. It required 400 g of flour. The recording mechanism to the left was actuated by a series of rods attached to the movable bowl. Because of the large amount of flour required, it was not suitable for wheat improvement work, and because of its expense, only a few were ever marketed.

A smaller instrument requiring 35g of flour and having all the essentials of the original was designed and built in 1939 by Working (Fig. 8). The manufacture of this smaller recording mixer was assumed at that time by the National Manufacturing Co. of Lincoln, Nebraska, after several simplifications and modifications had been made, including a coiled spring to control the movements of the recording pen (Fig. 9). The damping mechanism was later changed to a string and spool

arrangement, recently replaced by additional weight on the swinging arm (Stearns and Barta 1990). John A. Johnson of the Department of Grain Science and Industries is said to have first used the terms "Mixograph" and "mixogram".

In the mid-1940s, Karl Finney modified the straight bowl sides by flanging them thus preventing or minimizing the spilling of flour from the bowl during the early part of mixing (Finney et al. 1950).

Fractionation and reconstitution studies conducted in the Hard Winter Wheat Quality Laboratory in the late 1960's necessitated the development of a 10g baking system with its accompanying 10g dough mixer (Shogren et al. 1969), leading in turn to the development of the 10g Mixograph (Finney and Shogren 1972). Finney has further modified it to one requiring 5g of flour (Finney 1989), and Rath and co-workers (Rath et al. 1990) have developed a recording mixer requiring only 2g of flour. Other successful attempts at recording dough mixing properties are on record (Brabender 1932, Malloch 1938, Swanson 1943, Voisey et al. 1966).

**REFERENCES**


Brabender, C. W. 1932. Studies with the Farinograph for predicting the most suitable types of American export wheat and flours for mixing with European soft wheats and flours. Cereal Chem. 9:617-627.

Finney, K. F. 1989. A five-gram Mixograph to determine and predict functional properties of wheat flours. Cereal Chem. 66(6):527-530.

Finney, K. F., Morris, V. H. and Yamazaki, W. T. 1950. Micro versus Macro cooking baking procedures for evaluating the cookie quality of wheat varieties. Cereal Chem. 27(1):42-49.

Finney, K. F. and Shogren, M. D. 1972. A ten-gram Mixograph for determining and predicting functional properties of wheat flours. Bakers Digest. 46(2):32-35, 77.

Malloch, J. G. 1938. Some results with a new recording mixer for use with small samples. Cereal Chem. 15(4):423-438.

Rath, C. R., Gras, P., Wrigley, C. W., and Walker, C. E. 1990. Evaluation of dough properties from two grams of flour using the Mixograph principle. Cereal Foods World 35(6):572-574.

Schiller, George. Personal communication, 1988.

Shogren, M. D., Finney, K. F., and Hoseney, R. C. 1969. Functional (breadmaking) and biochemical properties of wheat flour components. I. Solubilizing gluten and flour protein. Cereal Chem. 46(2):93-102.

Stearns, M. M. and Barta, S. 1990. Mixograph standardization/digital data acquisition. Cereal Foods World 35(5):485-488.

Swanson, C. O. 1929. The Origin and Development of the Department of Milling Industry. Department of Grain Science and Industry: Manhattan, KS.

Swanson, C. O. 1943. Physical Properties of Dough. Burgess Publishing Co.: Minneapolis, MN.

Swanson, C. O. and Working, E. B. 1926. Mechanical modification of dough to make it possible to bake bread with only the fermentation in the pan. Cereal Chem. 3(2):65-83.

Swanson, C. O. and Working, E. B. 1933. Testing the quality of flour by the recording dough mixer. Cereal Chem. 10(1):1-29.

Voisey, P. W., Miller, H., and Kloek, M. 1966. An electronic recording dough mixer. Parts I-IV. Cereal Chem. 43(4):408-419.

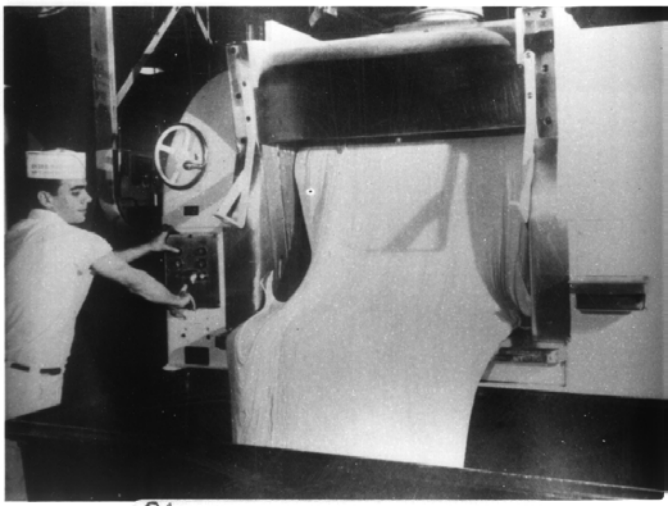



Fig. 1. Commercial bakery horizontal dough mixer.

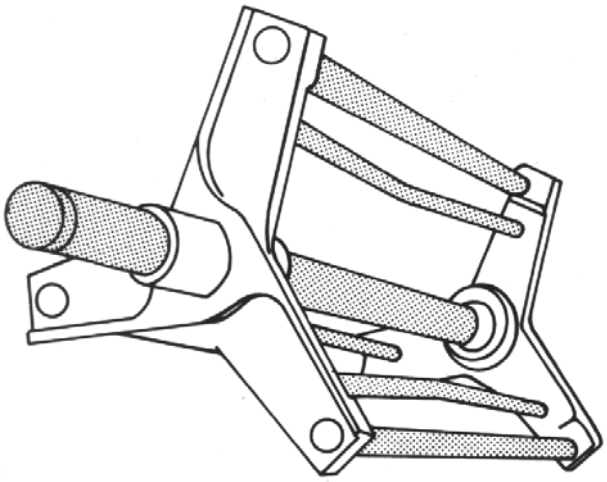


Fig. 2. Schematic drawing of mixing arms of commercial bakery horizontal dough mixer.

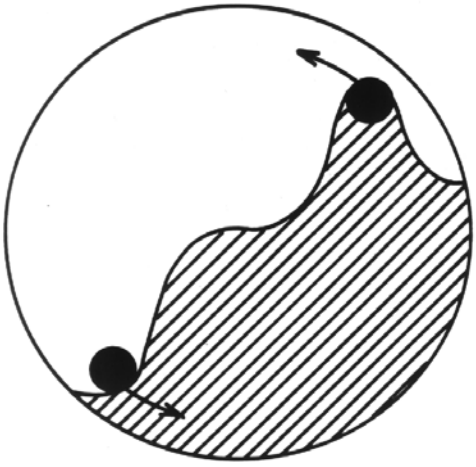


Fig. 3. Author's concept of C. O. Swanson's theory of "pull-back" of the dough (shaded area) against the mixing arms of the commercial horizontal dough mixer.

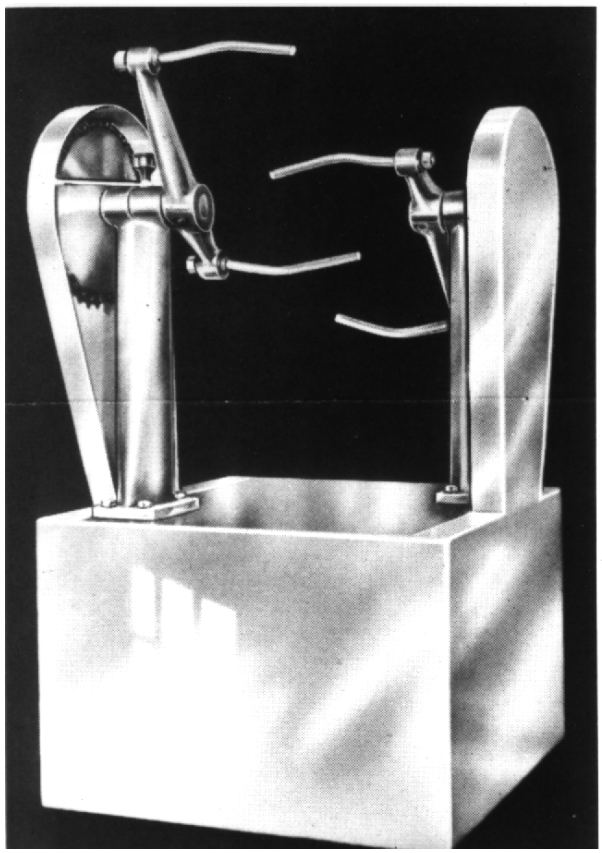


Fig. 4. Drawing of a commercial taffy candy puller.

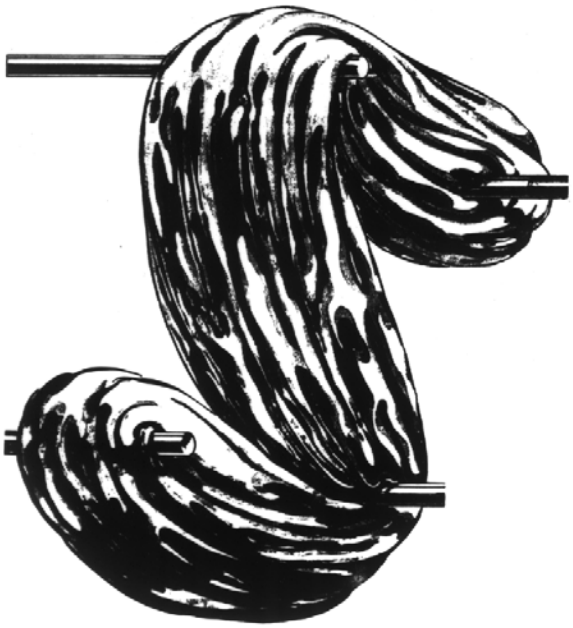


Fig. 5. Artists conception of taffy being pulled in a commercial taffy candy puller.

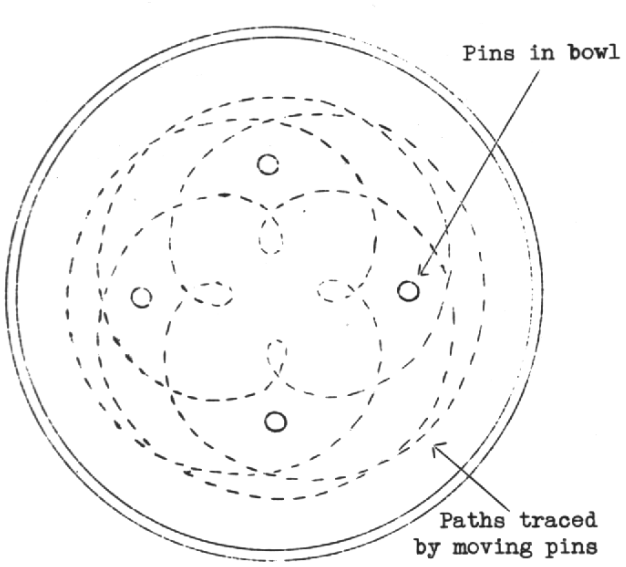



Fig. 6. Paths of moving pins relative to positions of fixed pins. (From Swanson and Working 1933).

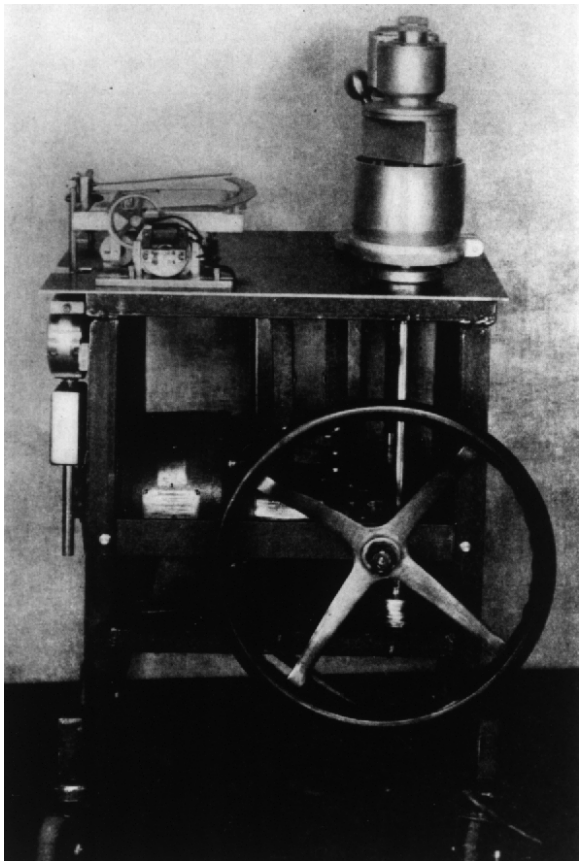


Fig. 7. Side view of recording mixer. (From Swanson and Working 1933).

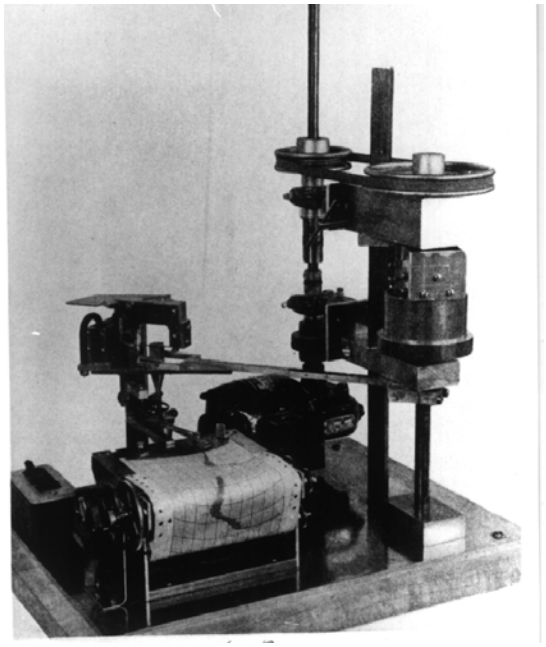


Fig. 8. Original 35-g Mixograph.

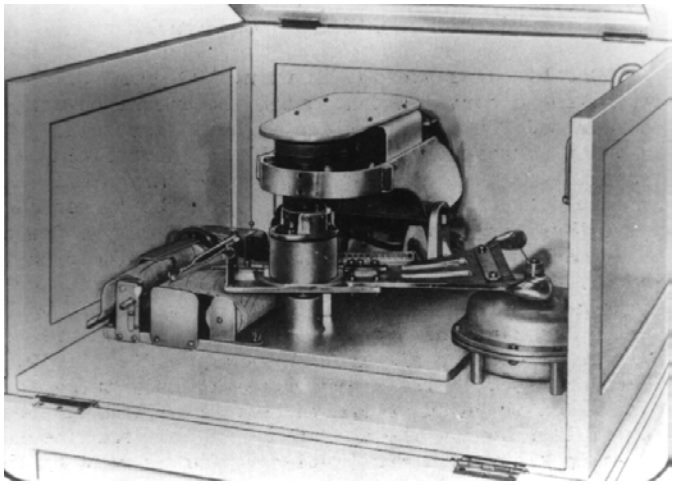


Fig. 9. Drawing of the 35-g Mixograph manufactured by National Manufacturing Co. of Lincoln, NE, in 1939. (From Swanson 1943).

# Chapter 2
## COMPARISON OF TWO RECORDING DOUGH MIXERS: THE FARINOGRAPH AND MIXOGRAPH

M. E. Ingelin

Agriculture Canada Winnipeg Research Station, Winnipeg, MB, Canada

In 1932, Brabender reported on the development of the Farinograph. While the following year, Swanson and Working (1933) describe another recording dough mixer, which later became known as the Mixograph. Brabender and others realized that although the Farinograph was quite suitable for testing flours made from European wheats, North American wheats produced doughs requiring more intensive mixing. He suggested that the standard Farinograph procedure could be adapted to include an intermediate rest before continued mixing, but it is not clear whether this recommendation was ever followed. Cullen-Refai and Faubion (1988) confirmed that relaxing a partially mixed dough could substitute for further mixing.

Swanson wanted to duplicate the pull-fold action of horizontal bakery mixers commonly used in the U.S. (Swanson and Working 1933). Compared to the Farinograph, the Mixograph's vertically oriented planetary pin design provided higher shear rates and more intensive mixing. As a research tool, the Mixograph was not as heavily marketed for routine testing, as was the Farinograph. Therefore, the Farinograph is much more widely used, particularly in Europe, whereas the Mixograph's use is largely limited to North America and Australia.

One of the characteristics shared by these instruments and other recording dough mixers is that they are empirical, not fundamental rheological instruments. Moderately high shear rates are needed to abrade flour particles, hydrate them, and develop doughs. Low shear rates are more appropriate for measuring stress and strain and other rheological measures, but higher stress rates tend to break the contact between the dough and the testing equipment (Weipert 1990).

These empirical recording mixers have been and will continue to be used in predicting the suitability of a flour for a given end product. Not all flours have the adequate combination of elasticity and extensibility required for bread production and other yeasted products. The curves from these mixers can determine if the doughs tested develop a suitable consistency and maintain this level as mixing continues (mixing tolerance).

Both the Mixograph and Farinograph have been used to predict dough processing requirements and end product quality with respect to absorption, mix time and stability, and loaf volume. Some Farinograph applications include cookies (Labuschange et al. 1996); pan bread (Dexter et al. 1994); steam bread (Huang et al. 1993); and tortillas (Suhendro et al. 1995). The Mixograph also has been used in a variety of applications. Some of these include cookies (Labuschange et al. 1996); bread (Knackstedt et al. 1994); noodles (Baik et al. 1994); and pasta (Kovacs et al. 1994). Such predictions are useful when screening large numbers of samples, or writing specifications for flour shipments.

Even with advances in electronics, information provided by the modern Mixographs and Farinographs must not be viewed as a substitute for actual bake tests. By estimating absorptions and mix times, these recording mixers can aid rapid bake testing by focusing on relevant ranges for these parameters. Without these preliminary estimates, bake testing would require more treatments (more time), or wider ranges of treatment levels (less precision in determinations).

### FARINOGRAPH

*General*

The Farinograph employs broad, sigmoid shaped paddles and measures dough consistency as it is kneaded between two of these blades (Fig. 1). The motor driving the mixing blades is not fixed, but moves within a limited arc on its rotational axis. This 'dynamometer' is mechanically linked via lever arms to an oil bath damper and a recording pen. A special chart paper, ruled in Brabender Units (BU), is used to record dough consistency. The mid-line or 500 BU line is highlighted in red print and defines optimum consistency. Sufficient water has been titrated into the mixing flour when the farinogram peak is centered on the 500BU line.

In the electronic version, a potentiometer is added to the recording pen arm axle. An analog/digital I/O card included in the electronics upgrade coverts the changing voltages to digital units, which are interpreted by the Farinograph software package. The software calculates the mix time, absorption, and mixing tolerance values that were previously done manually.

*Advantages*

The Farinograph is the most widely used recording mixer. The durability of the instrument may be partially responsible for this. The instrument is relatively easy to use, and for the most part, measurements are easily read and understood (D'Appolonia 1984). Novice users may require more attempts to titrate the optimum water amount, but the 500BU line provides a clearly defined target. Much work has been done correlating Farinograph data with results from other flour dough and bake tests (Miller et al. 1956, Tanaka and Tipples 1969, Preston and Kilborn 1984).

*Disadvantages*

Some flours produce farinograms having very sharp, early (prior to 2 min) peaks. Following this brief increase and subsequent drop in consistency, the dough consistency may remain unchanged for several minutes before it eventually

drops. These early peaks have been termed 'hydration peaks' and have little relationship to bread dough mixing properties (Tanaka and Tipples 1969). At this time, computer analysis can not differentiate a hydration peak from the true dough mixing peak. If the operator locates a hydration peak, the sample should be disregarded. The Brabender software program does allow manual over-riding for mix time determination.

The longer the farinogram peak time, the flatter this region of the curve becomes, and the more difficult it is to locate the peak. Extremely long mixing flours sometimes require more than 20 minutes of mixing. However, judging from the dough's appearance (very slack and sticky), these peaks are occurring long after the dough has broken down. Dough stickiness rather than elasticity or extensibility may be a factor at this point (Bloksma 1984).

Some researchers object to the concept of a single optimum consistency for all flours, and believe it is an oversimplification to assume that dough consistency is solely dependent on absorption (Faridi 1990, Hoseney and Finney 1974). Another criticism is that titrating water to reach optimum consistency is in effect linking mix time with dough consistency. In most cases, adjusting absorption to move the farinogram closer to the 500 BU line also changes the mixing time. A possible theory is that the water is acting as a plasticizer in the dough system. The more water in the dough, the less resistance to mixing it provides. The more fluid the dough, the less efficient the mixer becomes in abrading the flour particles, and the more time required to mix the dough to optimum. The longer the dough is mixed the more elastic it becomes and its resistance to extension is eroded. At higher absorption levels, by the time the optimum mix time is reached, the doughs have a lower consistency as measured by the Farinograph. Evidence supporting this theory is found in the nature of the gluten proteins themselves. Parades-Lopez and Bushuk (1983) found that protein structures within a wheat flour dough changed throughout the mixing process. They concluded that throughout the mixing process there was a shift from a continuous membranous structure to more individual fibrillar or globular elements. This change in protein structure may cause changes in dough consistency with time.

The above discussion considered farinograms from a single flour. When flours having a range of mix times are tested, calculated absorptions can be misleading. Flours with shorter mix times will have absorptions biased toward higher levels as compared with flours having longer mix times. Because the shorter mix times allow less time to degrade the protein structure, more water is needed to reduce dough consistency, thereby shifting the system toward longer mix times. Conversely, flours with longer mix times have relatively more of their dough structure broken down upon reaching farinogram peak time, so less water is used to increase their consistency.

Linking mix time with dough consistency may produce inconsistent results when predicting bake test parameters from Farinograph data. This would be especially true if the bakery mixer had a significantly longer or shorter mix time or a different mixing action than the Farinograph. The additional ingredients used in bread doughs may also alter mix times, which further weakens the relationship between bake and Farinograph absorptions.

**MIXOGRAPH**

*General*

The mixing element arrangement is quite different for these two recording mixers. In the Mixograph, two pairs of relatively thin pins rotating in a planetary motion replace the broad paddles of the Farinograph (Fig. 2). Also, the Mixograph bowl has three fixed pins to oppose the action of the moving pins. The Mixograph's mixing elements are oriented vertically, while the Farinograph is operated in a horizontal position.

Conventionally, the mixing bowl is free to rotate to a limited degree in response to torque transmitted through the dough. These movements are either recorded by a pen on chart paper or electronically via a potentiometer sensor, as in the Farinograph. Mixograms and farinograms appear different due both to the nature of the linkages transmitting torque forces from the dough to the potentiometer and to the fundamental differences in the mixing action (stretching and folding vs. kneading).

*Advantages*

The Mixograph is lighter, simpler, and less expensive than the Farinograph (Table 1). It takes up less counter space and uses standard two-phase 110VAC electrical power. The damping system has been simplified to a weighted plate and spring. The simpler design makes it easier to clean and standardize.

In general the Mixograph uses a smaller sample. The latest Mixograph model requires only 2g flour; the smallest Farinograph 10g. This is especially important when items to be studied, such as isolated proteins, are difficult to obtain in large quantities (Bekes et al. 1994). When mixed to optimum, the dough produced from this mixer can be used for tests measuring extensibility and stickiness.

The mixogram has no line denoting optimum consistency, as does the farinogram. This has the advantage of avoiding the linkage between mix time and absorption detailed above. However, the absence of this line does lead to problems determining absorption. When time allows, laboratories will often run an absorption series with the Mixograph. This procedure allows conformation of a tentative optimum absorption by bracketing it with both higher and lower absorptions. Since the mixogram can be run in less time (8 min vs. 20 minutes for the Farinograph), a series of three mixograms can be run in the same time that it takes to run a single farinogram.

Except when testing low protein flours, mixogram peaks are more clearly evident than those from the Farinograph. The change in measured dough consistency may result from the vertically oriented Mixograph pins interacting with the visco-elastic dough properties. The vertical mixing elements provide a relatively small surface to mix the dough. As more

flour hydrates, dough accumulates in front of and within the mixing elements, which increases the effective surface area making them more efficient. Flour is hydrated at a faster rate and the resulting dough continues to accumulate, eventually forming a column of dough around the bowl pins bounded by the moving pins. Once the dough starts to lose elasticity the mixing pins may not be able maintain this column configuration and the dough sometimes falls toward the bottom of the mixing bowl and begins to plate up the bowl sides as dough consistency rapidly decreases. Because the Mixograph has smaller mixing elements than the Farinograph, the rate at which dough accumulates and eventually falls away has a greater effect in determining the mixogram's characteristics. A consequence of this is that, compared to the Farinograph, the measured Mixograph dough consistency is more closely related to actual dough properties that develop in commercial U.S. bread dough mixers.

Compared to farinograms, mixograms do not demonstrate hydration peaks as often or to the same degree. This might relate to the relative amounts of surface area of the mixing elements. When Hazelton and Walker (1994) varied the pin diameter of a 35g Mixograph bowl, they found that the wider the pin diameter, the more prominent the hydration peaks became.

*Disadvantages*

Since the Mixograph's development, the importance of temperature has been noted, though many researchers do not address this issue (Swanson and Working 1933, Harris et al. 1944). Harris and co-workers (1944) found that deviations in temperature had a greater effect on mixograms of hard red spring wheat flours than did protein content. Because of the importance of controlling laboratory temperature and its effects on mixing properties, a temperature-controlled cabinet was developed, but was not very successful (Finney and Shogren 1972).

As an alternative method, water-jacketed bowls, have also been used (Voisey and Miller 1970, Shelke and Walker 1990). This technique helped control dough temperature but was not entirely effective. Once the dough is sufficiently hydrated it forms a column around the bowl pins and has little contact with the floor of the mixing bowl. As it stands now, the best practice is to maintain good laboratory temperature control, preferably close to that recommended by Finney and Shogren (1972).

With the introduction of electronics, various methods of obtaining digitized and analogue readings of mixing torque or its energy value have been developed (Voisey et al. 1966, Voisey and Miller 1970, Streans and Barta 1990, Walker and Walker 1990, Wooding and Walker 1992, Gras et. al 1990). There still is not a clear consensus which Mixograph measurements are most important, and as a result three techniques are in existence today. The Canadians, Americans, and Australians developed their systems independently of each other and thus are not interchangeable. One of the American systems, MixSmart©, has been adopted by the Mixograph manufacturer and is commercially available.

The conventional, moving bowl Mixograph can be modified by fixing the bowl in a (near) stationary position (Wooding and Walker 1992). They either record torque via force transducers or measure the current required to maintain the mixing elements revolving at a constant speed. Mixograms from the fixed-bowl Mixograph configuration generally have wider bands than those from moving-bowl design. Further hardware and software modifications have been developed to make these mixograms appear more like conventional moving-bowl traces (Hazelton and Walker 1996).

It is difficult to select appropriate mix times for low protein flours (<8%), because their resulting mixograms are very flat. Such mixograms can often be misinterpreted as to possessing long mixing requirements and high mixing tolerance. Finney and Shogren (1972) believed that at these low levels of protein, it takes more time to form the continuous gluten phase in fully developed doughs.

One of the more common complaints centers on determining proper absorption. Some labs avoid this problem by using constant absorption (Dick et al. 1977). Flour quality is then measured against standard reference mixograms. While others use an absorption method based on flour moisture and protein content (Finney 1945, AACC 1995). Yet another method requires the user to adjust absorption based on a trial curve. Other labs use Farinograph absorption with the Mixograph. As noted later, the assumption that these measures are related is not always valid.

The standard AACC procedure (method 54-40A) estimates the starting absorption based on flour protein, calculated on a 14% moisture basis, in which % Absorption = 1.5 (protein content) + 43.6. A common approach brackets this absorption with 2% or 3% increments to confirm that the initial approximation is indeed optimum.

Subjective evaluations of Mixograph absorption balance the amount of 'sway' in the ascending limb vs. the amount of erratic responses (full scale changes in measured torque) in the same area of the mixogram. Too much sway indicates absorption was too high. Some amount of sway is acceptable when mix times are longer than average (over 4 minutes). Too many wild swings in torque measurement suggest that the dough being mixed is too dry. An optimized mixogram minimizes both of these parameters. This technique is inherently subjective. Across an absorption series, mixing (peak) times tend to increase and peak heights and bandwidths decrease with increasing absorption.

It would be quite feasible to set a similar arbitrary line on mixogram chart paper and adjust absorption to match peak height with it. At this time, there is sufficient opposition to this approach to prevent its introduction.

Mathematical models developed at Kansas State University provide objective determinations of Mixograph absorption (Ingelin et al. 1991, Hazelton et al 1997). The first model selects the mixogram having the optimum absorption from an absorption series of at least three mixograms. Ingelin (1995)

found that a 2% increment in Mixograph absorption could be resolved, especially by those experienced in reading mixograms. The model is based on the principle that as absorption increases, mixing time also increases. Data also indicated that the peak bandwidth is inversely proportional to absorption.

To use this technique, the mixing times for an absorption series should not vary more than 0.5 min per 2% absorption change. Differences in mixing time greater than this bias the results toward mixograms having the longer mix times. Assuming that the mix times of the series fall within this limit, the peak bandwidth is noted for each mixogram. The mixogram having the highest product of peak time and peak width is considered to have the best absorption. Since most electronically instrumented Mixographs measure peak width as well as mixing time, this simple equation can be widely applied.

For the 2g direct-drive Mixograph, determining proper absorption is even more difficult because of the rather wide and consistent bandwidth common to its design. Therefore, a regression model was developed to predict proper Mixograph absorption based on chemical analysis and the results from a single 2g Mixograph trial (Hazelton et al. 1997). More information on this subject can be obtained from Chapter 6, *Mixograph Measurements and Objective Absorption Determination*. A collaborative study to develop a prediction model for the 10g and 35g moving bowl Mixographs is currently underway (Hazelton and Walker 1997).

**CORRELATIONS BETWEEN THE INSTRUMENTS**

For many years, in cooperation with the Wheat Quality Council, the Department of Grain Science and Industry at Kansas State University has examined the quality of new wheat varieties. A set of 24 samples from the 1994 Small Scale series are reported in Table 2 and Figures 3-4. Both the Mixograph and Farinograph were operated in the computerized format and their data were likewise evaluated using MixSmart and Brabender software packages, respectively. Mixograph absorption was determined using the method developed by Ingelin (1995). Bake tests were conducted on 100g flour (14% mb). Bake mix times were determined using a power meter in conjunction with MixSmart software (Ingelin et al. 1994). Bake absorptions were optimized using Response Surface techniques.

No relationship was found between Mixograph and Farinograph absorptions and mix times. Neither the Mixograph nor the Farinograph was able to predict optimum bake absorption. However, other studies have shown better comparisons, which may be attributed to different optimum absorption selection methods (Johnson et al. 1943, Johnson et al. 1946, Finney and Barmore 1948, Miller et al. 1956, Tanaka and Tipples 1969, Finney and Shogren 1972). In most cases, Mixograph absorption is higher than Farinograph absorption. A 6% range in absorption was chosen as optimum by Response Surface. This range is the limit in which problems in mixing (dry doughs) or processing (wet doughs) could occur. However, the Mixograph predicted bake mix times better than the Farinograph (Figs. 3-4). Lukow and Hussain (1995) also demonstrated that there was no relationship for mix times when comparing a 2g Mixograph and a 10g Farinograph, both run at the same absorption.

**CONCLUSIONS**

It is evident that, although the Mixograph and Farinograph both measure dough mixing times and absorptions, there are no good correlations between the values the two instruments produce. This may be a function of the different mixing actions they employ. Although it would be convenient to convert measurements from one instrument to the other, at this time such conversions are not reliable.

It is the relationship of these recording mixers to end product quality that is more relevant. Despite limitations including false hydration peaks (Farinograph) and in determining absorption (Mixograph) both of these instruments have been successfully used in setting specifications for flour quality. Before using these mixers for this purpose, it is important for the supplier and purchaser to agree upon exactly what constitutes a hydration peak and how Mixograph absorption is to be measured.

There is little relationship between Mixograph and Farinograph absorptions or mix times. How then is it possible for both machines to be used successfully in predicting bake test parameters? Bake test absorptions are not always determined by running seven or more doughs per a statistically based RSM design. When bake tests are done as a part of a screening process involving very large numbers of samples, true optimization of bake test variables may be impossible. Quite often a Mixograph or Farinograph absorption, plus or minus some correction factor, is assumed appropriate, at least for the first absorption approximation for the bake test (Kilborn and Tipples 1981, Qarooni et al. 1993). The same can be said for determining proper mix times. As long as the estimates from these recording mixers produce doughs with appropriate consistencies, there will be little motivation to switch to more statistically correct designs involving more dough treatments. Further work with the Mixograph and Farinograph is needed to improve the data collection process, thus making such large scale bake tests as meaningful as possible.

To some cereal chemists, the ultimate goal in assessing flour quality is a ‘black box’ that would rapidly and objectively produce measurements that have some importance to categorizing flours. The Mixograph and Farinograph may be viewed as long tests that lack practical or rheological significance, but the current technology, when used appropriately, does provide valuable information regarding dough mixing properties.

Future developments will continue to make Mixograph and Farinograph data increasingly significant and applicable over a wide range of products. Possible investigations into mixer speed and the mixing element configuration could improve mixing peak resolution and flour absorption correlations between recording mixers and bake tests. In addition, an objective method for determining optimum bake absorption is

needed. Comparing subjectively determined Mixograph absorptions to equally subjective bake absorptions would do little to aid our understanding of dough systems.

Advanced software using elements of artificial intelligence or 'fuzzy logic' might solve the same problems. Computing speed and storage capacity have increased exponentially since the latest versions of the Mixograph and Farinograph software were issued. What mixing curve properties should the next generation of these programs be measuring? Who should decide this, and on what basis? Is it desirable to shorten the time required for these tests; might higher mixing speeds accomplish this? Alloys are now available to withstand the higher torque forces produced. Kilborn and Tipples (1972) used a lab scale bakery mixer to investigate the potential of mixing doughs at a constant energy input. Dough mixing recordings from this system plotted mixer RPM vs. Time. These researchers suggest possible savings in mixing time using this procedure. This technology has yet to be investigated in either the Mixograph or Farinograph. How would such a curve best be analyzed?

As cereal scientists, we should not become complacent or conservative in the use of these mixers. These recording mixers perform their current functions well enough, but are these the limits of their potential? If so, how can they better perform them? If not, what further applications are to be explored? In his discussion of RSM techniques, Myers (1971) states: "In fact, the model fitting aspect of RSM only represents empirical devices and when it is determined that a model is adequate by our criterion, it means that the existence of such a model was not contradicted by the evidence, namely, the data. The scientist should constantly be in search of the true structure of the system so that eventually he may not have to resort to empirical devices."

Mixographs and Farinographs are empirical devices just as much as the statistical modeling techniques. Cereal scientists are also attempting to define systems relevant to their work and recording mixers should be seen as a means to this end, not a substitute for needed further research. Such research can only be accomplished through continued collaboration between scientists, the foods industry, and the instrument makers.

**REFERENCES**


American Association of Cereal Chemists. 1995. Approved Methods of the AACC, 9th ed. Method 54-40A, Approved April 1961, revised October 1988. The Association: St. Paul, MN.

Baik, B. K., Czuchajowska, Z., and Pomeranz, Y. 1994. An SDS-FY test to evaluate quality of wheat for Oriental noodles. J. Cereal Sci. 20(2):191-201.

Bekes, F., Gras, P. W., Gupta, R. B., Hickman, D. R., and Tatham, A. S. 1994. Effects of a high Mr glutenin subunit (1BX20) on the dough mixing properties of wheat flour. J. Cereal Sci. 19(1):3-7.

Bloksma, A. M. 1984. Theroretical aspects of the Farinograph. Pages 7-12 in: The Farinograph Handbook. B. L. D'Appolonia, and W. H. Kunnerth eds. Amer. Assoc. Cereal Chem.: St. Paul, MN.

Brabender, C. W. 1932. Studies with the Farinograph for predicting the most suitable types of American export wheat and flours for mixing with European wheats and flours. Cereal Chem. 9:617-627.

Cullen-Refai, A. and Faubion, J. M. 1988. Lubricated uniaxial compression. Cereal Chem. 65(5): 401-407.

D'Appolonia, B. L. 1984. Types of Farinograph curves and factors affecting them. Pages 13-23 in: The Farinograph Handbook. B. L. D'Appolonia and W. H. Kunerth eds. Am. Assoc. of Cereal Chem.: St. Paul, MN.

Dexter, J. E., Preston, K. R., Martin, D. G., and Gander, E. J. 1994. The effects of protein content and starch damage on the physical dough properties and bread-making quality of Canadian durum wheat. J. Cereal Sci. 20(2):139-151.

Dick, J. W., Shuey, W. C. and Banasik, O. J. 1977. Adjustment of rheological properties of flour by fine grinding and air classification. Cereal Chem. 54(2): 246-255.

Faridi, J. 1990. Farinograph and alveograph applications in flour testing. AIB Techn. Bulletin 12(7).

Finney, K.F. 1945. Methods of estimating and the effect of variety and protein level on the baking absorption of flour. Cereal Chem. 22 (2): 149-158.

Finney, K. F. and Barmore, M. A. 1948. Loaf volume and protein content of hard winter and spring wheats. Cereal Chem. 25(5):291-312.

Finney, K. F. and Shogren, M. D. 1972. A ten gram Mixograph for determining and predicting functional properties of wheat flours. Baker's Digest 46(2):32-35, 38-42, 77.

Gras, P. W., Hibberd, G. E., and Walker, C. E. 1990. Electronic sensing and interpretation of dough properties using a 35-g Mixograph. Cereal Foods World 35(6):568-571.

Harris, R. H., Sibbet, L. D., and Scott, G. M. 1944. The effect of temperature differences on some mixogram properties of hard red spring wheat flours. Cereal Chem. 21(5):375-385.

Hazelton, J. L., Chung, O. K., Eastman, J. J., Lang, C. E., McCluskey, P. J., Miller, R. A., Shipman, M. J., and Walker, C. E. 1997. Regression equation for predicting absorption for the 2-g direct drive Mixograph. Cereal Chem. 74(4):400-402.

Hazelton, J. L. and Walker, C. E. 1994. Changes in mixograms resulting from variations in shear caused by different bowl pin sizes. Cereal Chem. 71(6):632-634.

Hazelton, J. L. and Walker, C. E. 1996. Changing mixogram appearance by sampling at fixed as opposed to random head position. Cereal Foods World 41(7):631-634.

Hazelton, J. L. and Walker, C. E. 1997. An objective method for predicting moving bowl Mixograph absorption. Cereal Foods World 42(8):614 – abstract #76.

Hoseney, R. C. and Finney, P. L. 1974. Mixing - a contrary view. Baker's Digest 48(1):22-28.

Huang, S., Betker, S., Quail, K., and Moss, R. 1993. An optimized processing procedure by response surface methodology (RSM) for northern-style Chinese steamed bread. J. Cereal Sci. 18(1):89-102.

Ingelin, M. E. 1995. Measurement of Dough Properties and Their Use in Predicting White Pan Bread Quality. Ph.D.

dissertation. Department of Grain Science and Industry, Kansas State University, Manhattan, KS.

Ingelin, M. E., Dogan, I., Ponte, J. G. Jr., and Jones, B. 1994. Objective measurement of bakery mix times. National Notes 2(1):7-9.

Ingelin, M. E., Ponte, J. G. Jr., and Walker, C. E. 1991. A model for predicting and evaluating Mixograph absorption. Cereal Foods World 36(8): 682 - abstract #21.

Johnson, J. A., Shellenberger, J. A, and Swanson, C. O. 1946. Farinograms and mixograms as a means of evaluating flours for specific uses. Cereal Chem. 23(4):388-399.

Johnson, J. A., Swanson, C. O., and Bayfield, E. G. 1943. The correlation of mixograms with baking results. Cereal Chem. 20(5):625-644.

Kilborn, R. H. and Tipples, K. H. 1972. Factors affecting mechanical dough development II. Implications of mixing at a constant rate of energy input. Cereal Chem. 49(1):48-53.

Kilborn, R. H. and Tipples, K. H. 1981. Canadian Test Baking Procedures. I. GRL Remix method and variations. Cereal Foods World 26(11):624-627.

Knackstedt, M. A., Sears, R. G., Rogers, D. E., and Lookhart, G. L. 1994. Effects of T2BS.2RL Wheat - Rye translocation on breadmaking quality in wheat. Crop Sci. 34(4):1066-1070.

Kovacs, M. I. P., Dahlke, G., and Noll, J. S. 1994. Gluten viscoelasticity: its usefulness in the Canadian durum wheat breeding program. J. Cereal Sci. 19(3):251-257.

Labuschange, M. T., Coetzee, M. C. B. and VanDeventer, C. S. 1996. Biscuit-making quality prediction using heritability estimates and correlations. J. Sci. of Food and Agr. 70(1):25-28.

Lukow, O. M. and Hussain, A. 1995. Protein quantity and quality effects on Mixograph parameters. Cereal Foods World 40(9):668-669 - abstract #177.

Miller, B. S., Hays, B., and Johnson, J. A. 1956. Correlation of Farinograph, Mixograph, sedimentation and baking data for hard red winter wheat flour samples varying widely in quality. Cereal Chem. 33(5):277-289.

Myers, R. H. 1971. Response Surface Methodology. Allyn and Bacon, Inc. Boston, MA.

Parades-Lopez, O. and Bushuk, W. 1983. Development and undevelopment of wheat dough by mixing: Microscopic structure and its relation to breadmaking quality. Cereal Chem. 60(1):24-26.

Preston, K. R. and Kilborn, R. H. 1984. Dough rheology and the Farinograph. Pages 38-40 in: The Farinograph Handbook. B. L. D'Appolonia and W. H. Kunerth eds. Am. Assoc. of Cereal Chem.: St. Paul, MN.

Qarooni, J., Posner, E. S. and Ponte, J. G. Jr. 1993. Production of pita bread with hard white and other U.S. wheats. Lebens.-Wiss. u_Technol. 26(2):93-99.

Shelke, K. and Walker, C. E. 1990. A water-jacketed bowl for Mixograph temperature control. Cereal Foods World 35(6): 575-577.

Stearns, M., and Barta, S. 1990. Mixograph standardization/digital data acquisition. Cereal Foods World 35(5):485-488.

Suhendro, E. L., White, N. D. G., and Sinha, R. N. 1995. Effects of polyols on the processing and qualities of wheat tortillas. Cereal Chem. 72(1):122-127.

Swanson, C. O. and Working, E. B. 1933. Testing the quality of flour by the recording dough mixer. Cereal Chem. 10(1):1-29.

Tanaka, K. and Tipples, K. H. 1969. Relationship between Farinograph and mixing requirements. Cereal Sci. Today 14(9):296-300.

Voisey, P. W., and Miller, H. 1970. The Ottawa electronic recording dough mixer. VII. Factors affecting performance and the use of digital recording technique. Cereal Chem. 47(2):207-219.

Voisey, P. W., Miller, H., and Kloek, M. 1966. An electronic recording dough mixer. Parts I-IV. Cereal Chem. 43(4):408-419.

Walker, C. E. and Walker, A. E. 1990. Mixograph data acquisition and analysis by personal computer. Cereal Foods World. 35:823. (Abstract).

Weipert, D. 1990. The benefits of basic rheometry in studying dough rheology. Cereal Chem. 67(4):311-317.

Wooding, A. R. and Walker, C. E. 1992. Comparison of alternative recording mechanisms (fixed vs. Mobile) for the 35 and 10 g Mixograph. Cereal Chem. 69(3):249-253.

# TABLE 1.

## Approximate Farinograph and Mixograph Costs (1996 - $U.S.)

| | | |
|---|---|---|
| Farinograph | | |
| Basic Unit | | 16,900 |
| 300g. Bowl | | 9,950 |
| Water Bath | | 3,600 |
| Conversion Kit* | | 2,400 |
| | Total | $ 31,700 |
| Mixograph | | |
| Basic Unit | | 7,800 |
| 10g. Bowl | | 200 |
| Conversion Kit* | | 2,500 |
| | Total | $ 10,500 |

* Electronic conversion kit includes software and cables. Computers, printers, and monitors are extra.

## TABLE 2.

### Correlations from Kansas State University 1994 Small Scale Flour Testing Data

| Mixograph | Farinograph | Bake Test | $R^2$ |
|---|---|---|---|
| Mix Time | Mix Time | --- | 0.04 |
| Absorption | Absorption | --- | 0.18 |
| Absorption | --- | Absorption | 0.49 |
| --- | Absorption | Absorption | 0.22 |
| Mix Time | --- | Mix Time | 0.91 |
| --- | Mix Time | Mix Time | 0.02 |

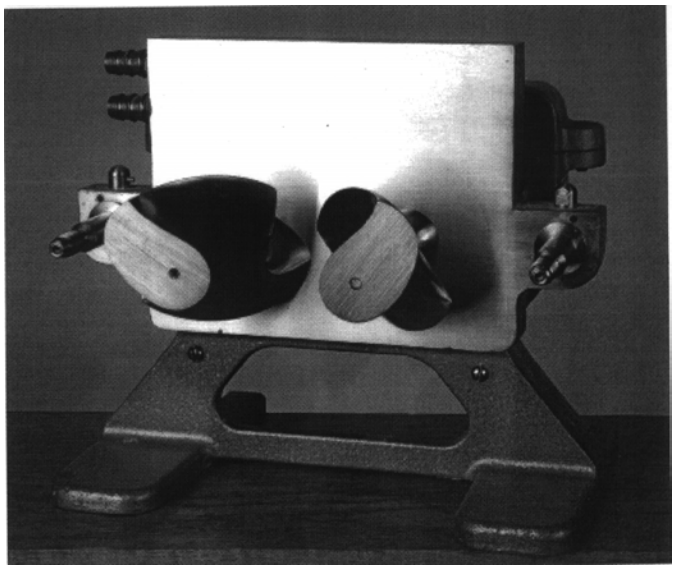


Fig. 1 The Farinograph employs broad, sigmoid shaped paddles that gently knead the dough. (courtesy of C. W. Brabender Instruments, Inc.)

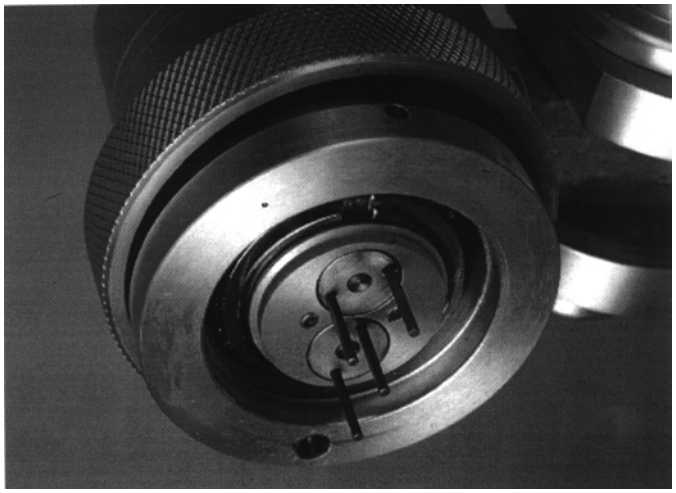


Fig. 2 The Mixograph employs two pairs of relatively thin pins which rotate in a planetary motion.

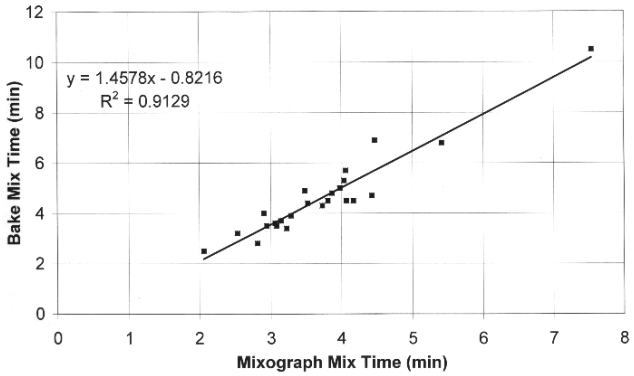



Fig. 3 A comparison of Mixograph mix time and bake mix time.

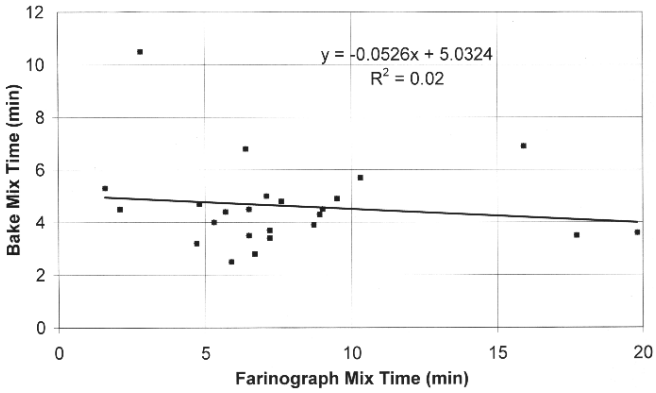



Fig. 4 A comparison of Farinograph mix time and bake mix time.

# METHODOLOGY

# Chapter 3
## OPERATING INSTRUCTIONS FOR THE 10-GRAM AND 35-GRAM MIXOGRAPHS

M. D. Shogren

USDA - ARS - GMPRC, Ret., Manhattan, KS, USA.

The Mixograph is a precision instrument. With careful use and a good maintenance program, it will be trouble free for many years. For other detailed information refer to the official method, AACC Method 54-40A (1991) and "A ten-gram Mixograph for determining and predicting functional properties of wheat flour" by Finney and Shogren (1972).

Schematic drawings of the 10- and 35g instruments are shown in Figures 1 and 2. Their components are described in the captions accompanying each figure. Mechanically, the instruments are the same except for the size of the mixing head, bowls, and damping systems. Neither the drawings nor this discussion address the special features associated with the computerized Mixograph.

Since their inception, few basic changes have been made to either the 10- or 35g Mixographs. The damping arm of the 10g machine was similar in size and shape to that of the 35g instrument but not as heavy. The older damping design had a forked damping arm with stops located at the end of the fork (Fig. 2). Damping was accomplished not only by the mass of the bowl platform and its arm but by the string and spool system which restrains the movement of the bowl platform. On newer models, the forked damping arm was replaced with a rectangular shape and the damping arm stops are mounted on the post directly behind the bowl (Fig. 1). A weight is used to achieve an inertial damping effect. The stops used with either type of damping arm are adjusted by bending slightly. For normal operation, the spring is attached in slot #12.

### SETTING UP THE INSTRUMENT

Since the chart paper exits to the left, the cabinet should be situated at the left end of a bench or table top to allow room for the chart paper to hang freely. A weight should be attached to the end of the chart paper to assure constant tension. Large paper binders serve this purpose well. As the chart paper emerges it should be rolled and held in place with spring clips, one on each side of the rolled paper. See Figure 3 for correctly threading chart paper over drive and tension rolls.

Temperature does affect mixogram curve characteristics. At one time, the Mixograph was placed in a cabinet as a means of temperature control, but many people removed it for convenience. To ensure that the flour, water, and mixing bowl are at a consistent temperature, it is necessary to maintain a constant room temperature (usually 25º C).

A GraLab timer is included with the Mixograph. Connecting the electrical plug from the Mixograph into the timer outlet supplies electrical current to both the Mixograph motor and timer.

### INSTRUMENT CHECK

Although the Mixograph was properly adjusted at the factory, checking to insure proper adjustment will help to familiarize yourself with the instrument. It is necessary to have the Mixograph level. To check the clearance between the head pins and bowl bottom, first raise the mixing head by grasping the cradle rather than the top plate (the top plate houses the upper planetary bearings). Place the blank bowl bottom (aluminum disc) in the bowl receptacle and lower the cradle. Then using the 0.034-inch gauge, check the gap between the disc and the bottom ends of the planetary pins. The gap can be adjusted by loosening the lock nut and turning the screw mounted in the cradle just above the post where the cradle rests. To increases the gap, turn the screw clockwise or to decreases the gap, turn it counterclockwise. When finished, tighten the lock nut and recheck the gap.

Hand rotation of the head pins is not possible because of the grip of the V-belt and the gear reduction mechanism. With an Allen wrench, loosen the set-screw on the back pulley (not the front) so that it rotates freely on its shaft. Now the planetary can be rotated to assume different pin configurations. When rotating the planetary pins they should at some point assume the configuration of the template supplied (Fig. 4). When the pins are aligned with the template, an imaginary line (A) through the two front pins should be perpendicular to a line (B) representing the length of the Mixograph (front to rear). The idler pulley that keeps tension on the V-belt should be tightened only enough to keep the belt from slipping, otherwise, excessive wear in the planetary bearings may result.

The pen is attached to one end of the pen arm and a brass balance weight to the other. When tightened, the shaft to which the weight is attached serves as a means of locking the pen arm in place. When the bowl platform is perpendicular to the imaginary line B, the pen should come to rest on the middle line of the mixogram chart paper. If necessary, the shaft can be loosened and the pen arm moved to achieve proper alignment.

### GETTING STARTED

Disassemble the ink pen to familiarize yourself with its parts. Care must be taken not to bend the fine wire at the end of the stainless steel inner piece. Reassemble all but the ink reservoir. Fill ink reservoir and finish assembly. Shake the pen slightly until the tip inks paper. Screw into place in the pen arm and lower onto chart paper. Adjust bowl platform stops to limit the pen to the bottom and top lines of the chart paper. Advance chart paper until pen coincides with a major arc. Begin all mixograms at major arcs. Fold an absorbent paper several times and insert between the pen and the chart paper until ready to use and between curves, or raise the pen arm until the detent holds it

off the paper. (Some operators prefer to use either felt-tip pens designed for plotters, ballpoint, or fiber-tip pens instead. – Ed.)

Shape several tongue depressors to about 5/8" width and square off ends. Sharpen the square end of one of the pieces for later use. Weigh flour (10 or 35g on a 14 % mb) and place in bowl. Using a wood piece, form a well in the flour in the center of the bowl by forcing the flour to the sides of the bowl. Cover until ready to add water.

Prior to producing the first mixogram, allow Mixograph to run empty (warm up) for 30 min. Run the first two or three mixograms on a standard flour. Remove any pieces of dried dough that may have dislodged and fallen onto the bowl platform. Place mixing bowl onto bowl platform and latch it into position. Recheck to make sure bowl is properly seated. Failure to seat the bowl properly will cause the bowl to be raised and could cause the bowl bottom to be scored by the planetary pins or result in the moving and stationary pins becoming entangled, bent, and even broken.

**ABSORPTION ESTIMATE**

The optimum water absorption for a flour is influenced by differences in wheat and flour quality caused by genetic expression and environmental growing conditions and especially flour protein content. As an approximation, calculate Mixograph absorption as % Abs = 43.6 + 1.5(% protein), all on a 14% moisture flour weight basis. Run the test and observe the results, adjusting the absorption and repeating if necessary.

Mixograms from different wheat flours will likely be positioned at different heights on the chart paper. For examples of mixograms with optimum water absorption, please refer to Figure 1 in Chapter 16 by Rubenthaler entitled *Mixograph use at the U.S. Western Wheat Quality Laboratory*. The columns represent, from left to right, low, medium, and medium-high flour protein contents. Mixing times ranged from short (top) to long (bottom).

In general, mixograms of flours with average physical dough properties will, after 8 minutes of mixing, center on or about: the 50% chart line for 16.5 % flour protein content; the 40% chart line for 12.5 % protein; and 30% chart line for 8.5 % protein. For flours whose protein contents lie between these ranges, estimates will have to be made. Likewise, for flours having weak dough properties (shorter mix times), the mixogram tails will center lower on the graph than those of stronger flours. See Chapter 6 for a more detailed discussion.

**RECORDING THE MIXOGRAM**

Turn timer switch to OFF, set timer for desired time (8 minutes usually suffices), turn mixer and paper drive motor switches to ON. Remove the bowl cover, add the calculated amount of distilled water into the flour well, and place the bowl onto its platform. Next, lower the cradle until latched, lower pen on chart paper, and start mixer and chart paper simultaneously by turning the timer switch to ON.

Upon completing mixing, raise the cradle and secure the pen. Turn mixer switch to OFF, set timer for one or more minutes for the desired space between curves (chart drive is still ON), and turn timer switch to ON. While the chart paper is advancing, remove dough from planetary pins using a sharpened tongue depressor and clean pins and dough guard with liberal amounts of water. (Today, many operators prefer to use small, plastic kitchen spatulas with a small notch cut to accommodate the pins. – Ed.) Do not add salt to stiffen dough as it is quite corrosive and could cause the dough to become so stiff as to bend pins. (Some operators add a small amount of semolina or farina before cleaning. – Ed.) Remove mixing bowl and fill with water. Finish cleaning moving pins with a damp cloth followed by a dry cloth. Place second bowl and flour onto the bowl platform.

While the second dough is being mixed, clean the first bowl under a stream of water with the sharpened, square-ended wood piece. Dry the bowl and allow it to come to room temperature before reusing. Besides losing temperature control, a warm bowl may be difficult to place in its platform receptacle due to metal expansion. Care must by exercised in cleaning and drying the areas between the bowl pins and bowl sides. In the process, repeated pressure from forcing fingers against the bowl pins towards the center of the bowl can, in time, cause the pins to be bent inward, resulting in erratic swings in the mixogram curve.

The above routine provides an efficient means of utilizing time in producing mixograms. It requires that the moisture and protein contents of the flour samples be known beforehand and calculations for the amounts of water made. A good practice is to note date, flour sample, mixing bowl used, and other pertinent data in the margin below the mixogram.

The ink reservoir will require refilling after completing several curves. When finished, disassemble the pen, clean with water, and lay out on absorbent paper to dry.

**TROUBLE SHOOTING**

Improper seating of the bowl on the bowl platform probably causes more damage than any other procedural step. The bowl receptacle should be clean, dry, and free of dried dough pieces. Check proper seating by lowering the cradle and mixing head into place to determine that sufficient clearance is provided between the rotating pins and the bowl bottom. Improper seating may alter curve characteristics as well.

Lack of lubrication can cause the rotating planetary pin mechanism to seize. In such an event, if the instrument is not turned off immediately, the mixer motor will be ruined. There are three to four locations to apply a light weight mineral oil, including on each end of the planetary head; at the top of the planetary shaft; and at the front of the cradle just to the right of the upper set screw. The 35g model does not have the cradle oil hole. Only a few drops of oil are required for each day of use.

Care should be taken in calculating and dispensing the proper amount of water needed for a given flour sample. Doughs that are too stiff or dry can cause the bowl pins to bend and perhaps break.

Special consideration should be given to the older 35g models

because of their string and spool damping system. Improper threading of the string around the spool can result in distorted mixograms.

Should the Mixograph stop running and none of the above conditions are present, the problem likely is electrical, in which case the fuse should be checked and electrical continuity ascertained.

Especially for a Mixograph subjected to heavy use, it may be necessary to clean the platform bearings every two years to prevent sluggish platform movement. To accomplish this, locate the hole in the bottom of the Mixograph base. Remove the nut with a 3/4" socket wrench and remove the bottom bearing and the brass spacer. The bowl platform can then be removed from the top of the bearing housing. Clean the bearings and the bearing housing. Oil the bearings with a light-weight oil and reassemble, using care not to over tighten the nut.

Occasionally, doughs will alternately "ride" up the walls of the bowl, then return to the dough mass, usually resulting in alternately higher and lower swings on the mixogram tail. This is associated with doughs having very weak physical dough properties and high absorption water requirements.

Mixograms with wild swings can be caused by bowl pins not being perpendicular to the bowl bottom. One means of determining this is to stand the end of a steel rule along the side a pin, the end of the rule must be square to the bowl sides. In that way determine if the pin needs to be bent to perpendicular. Finger pressure may be sufficient to properly align the pin. Continued pin straightening can have adverse effects. The metal will fatigue, causing it to more easily get out of alignment, and eventually break.

If an instrument produces mixograms that are thinner, lower on the chart paper, and have slightly longer peak times than those produced on other instruments, the following checks may be advisable. There are several conditions that do or can create these types of curves, which include: 1) elevated operating temperature; 2) increased clearance between planetary pins and bowl bottom; 3) less flour, and therefore, less total dough weight; 4) increased absorption water; 5) worn planetary bearings; and 6) planetary not centered over bowl.

To check condition #6, loosen the set screw on the rear pulley, and with bowl firmly in place, rotate planetary so that the two round moving heads or hubs are aligned left to right with their centers being on a line parallel to the front edge of the Mixograph (Fig. 5). Measure, and compare, using machinists calipers, the distance from the outside edge of the right head (B) to the left outside bowl edge (C) and from the outside edge of the left head (A) to the outside right bowl edge (D). Repeat the measurement from front to rear after the planetary has been rotated one quarter of a turn or perpendicular to the front edge of the Mixograph platform. Those measurements, left and right, and front and back should be the same. Some left to right movement can be made by adjusting the cradle pivot screws. If there are any discrepancies in front to back measurements, contact the manufacturer.

**REFERENCES**

American Association of Cereal Chemists. 1991. Approved Methods of the AACC, 8th ed. Method 54-40A, approved April 1961, revised Oct. 1988. The Association: St. Paul, MN.

Finney, K. F. and Shogren, M. D. 1972. A Ten-gram Mixograph for determining and predicting functional properties of wheat flour. Bakers Digest. 46(2):32-35, 38-42, 77.

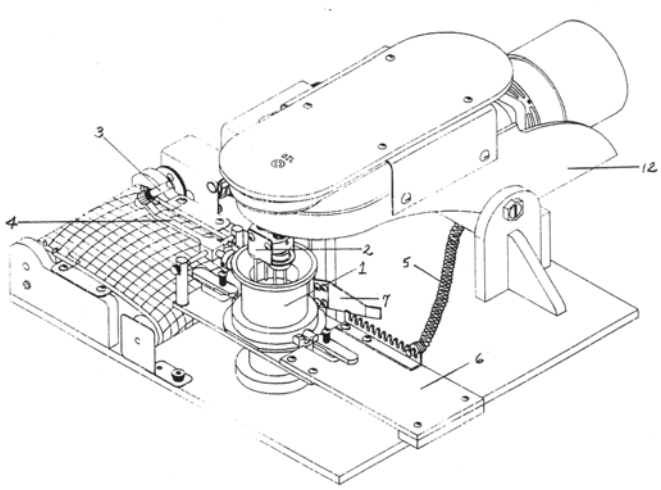



Fig. 1 10g Mixograph. The mixing head (#2) with two hubs having two pins each revolves in a planetary pattern about three stationary pins in the bowl (#1). Mixograms are recorded with a pen (#3) that is attached to the balanced pen arm (#4). For normal operation, the spring (#5) is attached in slot number 12. The mass of the bowl platform including the damping arm (#6) acts as the damping system. The stops (#7) limit platform rotation and recording pen arc length.

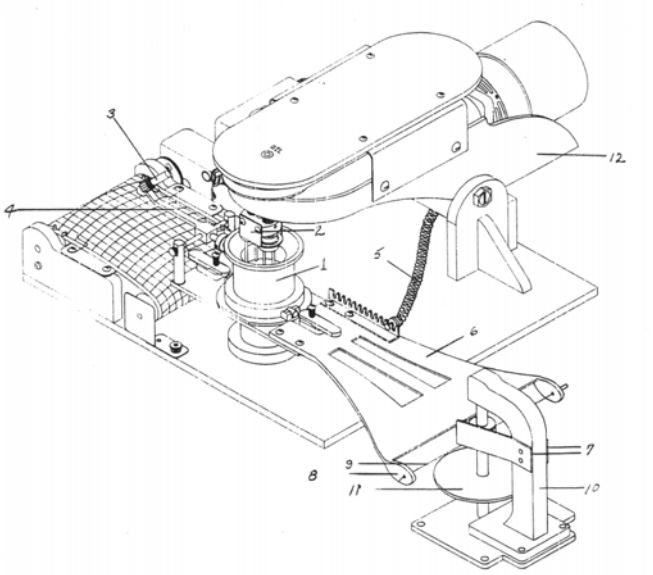



Fig. 2 35g Mixograph. The mixing head (#2) with two hubs having two pins each revolves in a planetary pattern about three stationary pins in the bowl (#1). Mixograms are recorded with a pen (#3) that is attached to the balanced pen arm (#4). For normal operation, the spring (#5) is attached in slot number 12. The mass of the bowl platform including the forked damping arm (#6) contributes to the damping system. The fork (#8) also serves to hold the spool-damping string (#9). The stops (#7) which are attached to the spool support post (#10) limit platform rotation and recording pen arc length. Further damping is provided by the rotating spool (#11) to which the string is attached.

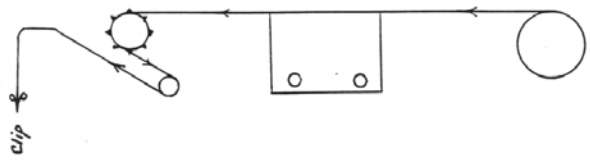



Fig. 3 Schematic drawing showing proper route of chart paper from chart roll over drive roll and under tension roll.

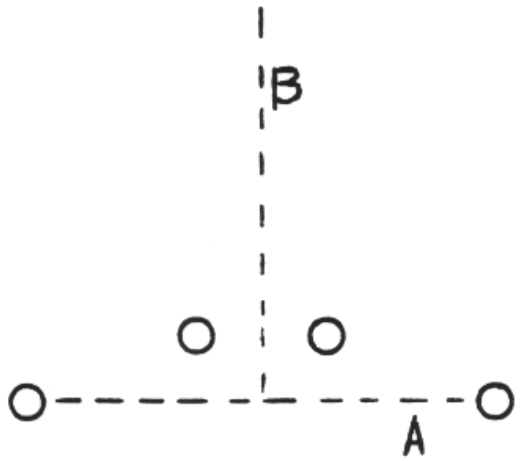



Fig. 4 Configuration of planetary pins according to the template supplied. A line between the widest pins (A) is perpendicular to a line (B) from front to back of the Mixograph, and parallel with the base plate front edge.

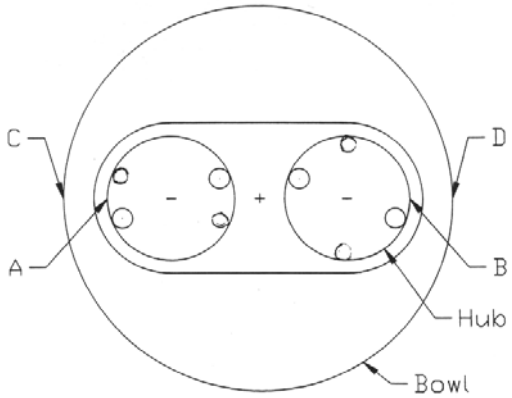



Fig. 5 Diagram of mixing head or planetary showing hubs A and B and the mixing bowl outside extremities C and D.

# Chapter 4
# THE 2-GRAM DIRECT DRIVE MIXOGRAPH

C. E. Walker and J. L. Hazelton

Dept. of Grain Science and Industry, Kansas State University, Manhattan, KS, USA.

The third and latest new direction in the Mixograph family is based on directly measuring the energy input to a constant speed direct drive mixing head. The theory behind the development of the direct drive design Mixograph came from re-examining the early work of Swanson and Working. Originally, they attempted to use a watt meter to record torque output, but this approach was not successful. Later, researchers found that power drawn by the motor to maintain a constant head speed could be monitored with a custom-built electronics unit, and that these fluctuations in power demand were an indication of the torque that was being transferred to the mixing bowl (Rath et al 1990). The direct-drive design offers some advantages in manufacturing and in use. The general design, first successfully applied to the 2g design (Fig. 1), is also applicable to larger scale (35g) Mixographs (Gras et al 1992). The fixed bowl, 2-gram, direct drive Mixograph derives its mixing curve from the current draw required to maintain a constant mixing speed. Mixing head speed is adjustable (normally run at 88.0 rpm).

A direct drive design has mechanical and electronic considerations, which make it both more and less sensitive than the earlier designs, the moving and fixed bowl models (Fig. 2). In the other two, the torque transmitted through the dough to the bowl pin is registered as the mixing curve. In the direct drive 'power demand' model, the torque measured at the power supply is affected by some factors in addition to the actual dough's resistance to mixing.

The drive train (motor bearings and gear box) are subject to some unavoidable friction. This can be partially factored out by proper 'no-load' calibrating the zero value. However, it has been observed that this value can change with operating temperature and wear after considerable use, so the user must continuously be aware of possible instrument drift.

Even without intermeshing bowl pins, the planetary head pins pairs do considerable work 'against each other', so the total power demand is greater than might be measured if only the transmitted torque were considered. This alternative 'push-pull' against the opposite pin pair increases the total work measured, which can be adjusted for in the calibration procedure. The center line or average can be adjusted during the full scale (100%) calibration procedure.

The direct drive system, especially in the small motor 2g model, is relatively sensitive to the 'two-pair' interaction referred to above and to other chance perturbations in the dough being mixed. The resulting curve is much wider than the familiar moving bowl mixogram, and wider even than the fixed-bowl (load-cell) mixogram when the latter does not incorporate torque sampling synchronized to the head pin position. Although it is theoretically possible to 'clip' the band width electronically or numerically, that feature has not yet been introduced commercially, and the very wide curves are objectionable to user familiar with the original system.

Mixograph temperature control has previously been advocated, and several papers published stressing that point (Finney and Shogren 1972, Shelke and Walker 1990), most advocating running the system at 25°C (77°F). This temperature is slightly above a normally comfortable laboratory, so various enclosures and other methods have been devised to control dough temperature. The small dough mass (about 3.2g) in the research instrument is very sensitive to atmospheric, bowl, and mixer head temperatures. Bowls with water-bath connections have been developed, but no attempts to date have been made to control the mixing head temperature that does rise with use.

Finally, the first commercial direct drive unit was for only a 2g flour sample. Its original stimulus was by researchers who were studying flour proteins by fractionating and re-combing them. Later, plant breeders purchased 2g models because they could advance their screening tests by one year or more. In either case, though, the small flour and water quality requires precise measurement and exacting sampling procedures coupled with the preceding points. Practically speaking, the 2g unit should be used in a research laboratory by skilled scientists, not as a routine test by semi-skilled operators.

Most Mixograph operators rely upon one or more of several common indicators to select the proper absorption. A 'starting point' must first be selected. This can be an arbitrary value; a fixed value for all samples; based on the history for that variety, growing season, or geographical area; or based upon other known characteristic such as protein content. Some operators run one sample then adjust from the starting value; others prefer to run an absorption series at 2% or 3% intervals, then compare the three to select the 'correct' Mixograph absorption. Individuals can become quite skilled at this.

Selecting the proper absorption when using the 2-gram direct drive Mixograph is even more difficult than for the conventional design. This is because of the rather wide curve resulting from the electronic sampling sensitivity and the dampening effect from the motor and power supply (Rath et al 1990). However, there are still changes in the

ascending curve “sway-back”, the overall “wildness”, the overall mixogram height, and the band width at various points. Hence, some combination of measurements might indicate whether or not the initial or trial absorption was correct and, if not, to predict an adjustment. One approach has been to develop a multiple regression equation to predict proper Mixograph absorption based on moisture and protein analysis and the results from a single Mixograph trial (Hazelton et al. 1997). More information can be obtained from Chapter 6, *Mixogram Measurements and Objective Absorption Determination*.

**REFERENCES**


Finney, K. F. and Shogren, M. D. 1972. A ten-gram Mixograph for determining and predicting functional properties of wheat flours. Baker’s Digest 46:32-42, 77.

Gras, P. W., Hibberd, G. E., and Walker, C. E. 1990. Electronic sensing and interpretation of dough properties using a 35-g Mixograph. Cereal Foods World 35(6):568-571.

Hazelton, J. L., Chung, O. K. Eastman, J. J., Lang, C. E., McCluskey, P. J., Miller, R. A., Shipman, M. A., and Walker, C. E. 1997. Regression equation for predicting absorption for 2-g Direct Drive Mixograph. Cereal Chem. 74(4):400-402.

Rath, C. R., Gras, P. W., Wrigley, C. W., and Walker, C. E. 1990. Evaluation of dough properties from two grams of flour using the Mixograph principle. Cereal Foods World 35:572-574.

Fig. 1 A 2g direct-drive Mixograph. (courtesy of M. E. Ingelin)

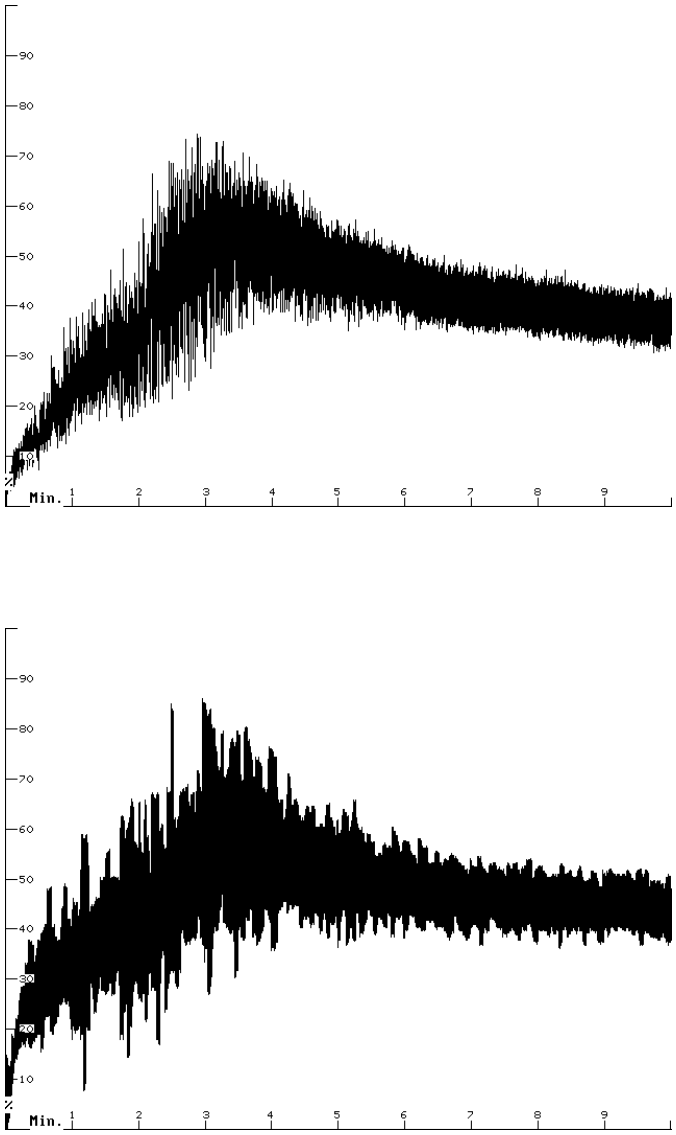



Fig. 2 Sample mixograms from both 2g direct-drive (top) and conventional 10g moving-bowl Mixographs (bottom).

# Chapter 5
# FACTORS INFLUENCING THE MIXOGRAM

K. F. Finney

USDA - GPMRC, Ret., and Dept. of Grain Science and Industry, Kansas State University, Emeritus, Manhattan, KS, USA.

## CULTIVAR (PROTEIN QUALITY)

A medium to medium-long mixing requirement, corresponding to the midline peak time of the top right mixogram in Figure 1, is generally the most desirable for bread baking (Finney et al. 1987). Thereafter (left to right and top to bottom), mixing properties vary from questionable to unsatisfactory. The width after the peak, and the stability of the mixogram height (slope) on each side of the peak, are indices of mixing tolerance. All flours used in Figure 1 contained about 12% protein, so the variations in mixing properties were functions of the cultivar's inherited protein qualities.

## ENVIRONMENT

The mixogram properties for a given cultivar may be similar over a wide range of environments (i.e. location, and weather) and crop years, to the extent that the mixing time may vary only 10-20% for that cultivar. There are, however, exceptions where climatic conditions affected mixogram peak time to vary by as much as 50-75% from an average time expected. For example, in Figure 1, the top-right mixogram could be similar to either the top-left or middle-left mixogram, depending on whether the cultivar had been grown under desirable or adverse climatological conditions, respectively.

## FLOUR PROTEIN CONTENT

At 7.5% protein, the mixing time of Pawnee was about 4.5 min; at 9.9% protein, mixing time decreased to 2.88 min; at 11.6% protein and above, mixing time was 2.13 to 2.38 min (Fig. 2) (Finney et al. 1987). Previous studies in our laboratory have shown that when protein content falls below about 12%, mixing time increases. This is primarily because of the greater difficulty in forming a continuous gluten phase. The higher the protein content, the higher the overall mixogram. Pawnee has a relatively short mixing time and mellow physical dough properties. The Qu/Tm//Mq/Oro blend has medium-strong to strong physical dough properties (Fig. 3). At 8% protein, mixing time was about 10 min; at 10.4% protein, mixing time decreased to about 7 min; at 11.5% protein, mixing time decreased to 5.38 min; and at 13.1% and 16.2% protein, mixing times were about 4.63 min. As with Pawnee, mixing time increased greatly as protein content decreased below about 12%. Thus, both protein quality and quantity affect the mixing properties of bread wheat flours.

## FLOUR ABSORPTION

The effects of decreasing or increasing water absorption from the optimum is illustrated in Figures 4 and 5 (Finney and Shogren 1972). As shown, stiff doughs produce mixograms having relatively wild swings, the extent of which depends on the degree of dough stiffness. Slack doughs generally produce unusually narrow mixograms that are characteristically swayback (except for KS501099 types) during hydrating and developing periods prior to reaching the peak or point of minimum mobility. Narrowness of the mixogram and extent of swaybackness are a function of the degree of slackness (except for KS501099 types, where a very poor quality protein hydrates and develops rapidly). Within a given cultivar, mixogram peak height decreases and time to peak generally increases, as absorption increases.

Baig and Hoseney (1977) studied four flours that had medium to long mixing requirements and various protein contents. By running an absorptions series for each flour (optimum and ± 3 percent from optimum) they were able to use a response surface technique to show that as flour absorption increased, mixogram height decreased and time to peak increased.

## TEMPERATURE

Mixograms were recorded at 20°, 25°, and 30° C on a 10g Mixograph in a temperature controlled cabinet. Flour and water were also maintained at the appropriate temperatures. Mixograms are routinely recorded at 25° C.

At 20° C, using the optimized absorptions as determined at 25° C (66.9% and 67.4% for AGSECO-7837 and TAM-107, respectively), peak height was larger when compared to those run at 25° C and there were many wild arcs, characteristic of stiff doughs (Fig. 6). Mixogram time to peak decreased about 1.25 min and 0.63 min, respectively. Increasing the flour absorptions by 3% gave mixograms essentially like those recorded at 25° C. Thus, for each 1° C below 25° C, peak mix time was decreased by 15 sec and 7.5 sec, respectively and flour absorptions had to be increased 0.6% per degree to obtain optimum absorption.

At 30° C, using the 25° C absorptions, the mixograms were relatively narrow and lower than those at 25° C, characteristic of slack doughs. Time to peak increased about 1.25 min for AGSECO-7837 and about 0.63 min for TAM-107. Decreasing the absorptions by 3% essentially reduced the mixogram peak times to the same as those at 25° C, but the mixogram widths and heights did not increase to the same values as at 25° C. Apparently at 30° C, the doughs were irreversibly softened (damaged), probably by increased proteolysis. Thus, for each 1° C above 25° C, peak mixing time increased 15 sec and 7.5 sec, respectively and their flour absorptions had to be decreased 0.6% per degree to obtain optimum absorption. When Baig and Hoseney (1977) varied temperatures from 25° to 40° C, they also reported that increased dough temperature decreased curve height and increased mixing time.

It should be emphasized that the flour, water, and subsequent dough are in contact with the bottom and sides of the Mixograph bowl only at the beginning of mixing, and are quickly picked up and mixed as a pillar between the confines of the planetary and bowl pins. Thus, it is imperative that the instrument, ingredients, and air all be maintained at the desired temperature.

**REPLICABILITY**

To demonstrate 5g and 10g Mixographs replicability, mixogram comparisons were made using four hard red winter (HRW) straight-grade flours (Finney 1989). The flours were selected to represent a wide range in functional, breadmaking properties. Cultivar A (Qu/Tm/Mq/Oro from the 1980 crop) had a long mixing requirement, other strong physical dough properties, and very good loaf volume potential. Cultivar B (KS501097 from 1980 crop) had a short to very short mixing requirement, other weak physical dough properties, and poor loaf volume potential. Cultivar C (Shawnee from the 1981 crop) had a high protein content, a medium-long mixing requirement, other good physical dough properties, and a very good loaf volume potential. Cultivar D (Newton from the 1983 crop) had a low protein content and resulted in a long mixing requirement, other good physical dough properties, and very good loaf volume potential when considering protein content. Flour protein contents and absorptions are given in Table 1.

Overall mixograms and peak times (points of minimum mobility) for the 5g and 10g instruments (Fig. 7, Table 1) are nearly identical for each of the four cultivars A, B, C, and D, both within and between replicates. Mixograms of cultivar D were low initially, rose slowly, and had abnormally long peak times (avg. 6.5 min), because of the low protein (8.7%) content (Table 1). Corrected to 12% protein, an expected peak time would be 4 min (Finney and Yamazaki 1967).

Analysis of variance (Table 2) was applied to mixogram peak times for the cultivars in Figure 7 and tabulated in Table 1. Variation was largely attributable to the wheat cultivars, because they represented a wide range in mixing time, but peak times of 5g and 10g mixograms within a cultivar were essentially equal. A peak time difference of 0.276 min between two single values was significant at $P>0.05$.

**FLOUR BLENDS**

Cultivars A and B from the section on replicability were used to make 100:0, 75:25, 50:50, 25:75, and 0:100 flour blends and thereby create a mixing time series that varied from about 6.0 to 1.63 min. Cultivars C and D were used to make 100:0, 75:25, 50:50, 25:75, and 0:100 flour blends, which represented a protein content series that varied from 18.6 to 8.7%. Mixograms were made on the 5g and 10g instruments (Finney 1989).

As the ranges for mixing time and flour protein content varied, overall mixograms and peak times for the 5g and 10g Mixographs were comparable for each of the five flour blends (Figs. 8 and 9, Table 3). Mixogram peak time was generally a linear function in relation to the amount of the component flours in the blend.

**DAMPING ARM**

Five HWW flours, each containing 12.4 ± 0.2% protein, were used when varying the weight of the damping arm on a 10g Mixograph. Flour #1 (Qu/Tm/ Mq/Oro), Flour #2 (Shawnee), and Flour #3 (RBS-70A) possessed good loaf-volume potentials and long, medium-long, and medium mixing time, respectively. Flour #4 (KS501097) and Flour #5 (KS501099) had poor loaf volume potentials and short mixing requirements. Mixogram absorptions (14% mb) were 61.7, 61.0, 62.5, 62.2, and 64.8%, respectively (Finney and Shogren 1972). Decreasing the weight of the damping arm from 392g to 219g increased the curve width and differentiation (Fig. 10). When the arm weight was reduced further to only 70g, mixograms were wider than necessary and required excessive amounts of ink.

**SPACE BETWEEN PLANETARY PINS AND BOTTOM OF BOWL**

Mixograms of two HWW flours were recorded on the 5g Mixograph for pin to bowl clearances of 0.014, 0.025, 0.033, 0.051, and 0.071 in (Finney 1989). A physically strong flour (83-S) with a medium-long dough mixing requirement and very good loaf volume potential was a composite of flours milled from many cultivars. Its absorption was 64.0% and protein content was 12.2% (14% mb). Flour from KS501097, had a short mixing requirement, other weak physical dough properties, a poor loaf volume potential, a protein content of 13.6% (14% mb), and an absorption of only 58.4% (14% mb).

As the space between planetary pins and bottom of bowl (hereafter referred to as "the space") increased from 0.014 to 0.071 in. for 83-S, mixogram height and width at peak gradually decreased, except for the space of 0.014 in (Fig. 11, left). There, after reaching the peak, dough was gradually deposited on the bottom of bowl. Because less dough was being mixed, the mixogram tail was relatively narrow and low on the paper relative to the space of 0.025 in. When the space was increased from 0.051 to 0.071 in., dough pickup was slowed considerably when compared to spaces 0.014 - 0.033 in. Peak times for spaces 0.051 and 0.071 in. were 0.5 to 0.75 min longer than the peak times for spaces 0.014 - 0.033 in.

As the space increased from 0.014 to 0.071 in. for the weak flour (KS501097), peak height again gradually decreased, but there were striking differences compared to the results for flour 83-S (Fig. 11, right). After reaching the peak for the 0.014 in. space, dough gradually accumulated on and finally covered the bottom and sides of bowl after 8 min of mixing. Accumulation of dough on the bottom and sides of bowl caused the mixogram tail height to decrease, because less dough was being mixed. Sharp rises of the mixogram tail occurred when some dough was temporarily picked up from the bottom and sides of bowl. When the space was increased to 0.025 in., the mixogram tail was improved up to 5 min. Thereafter, dough accumulated on the bottom and sides of bowl and after 8 min, covered the bottom and part way up the sides of bowl. A normal and uniform mixogram was obtained when the space was 0.033 in. When the space was increased to 0.051 in. and 0.071 in., peak times were increased by 0.5 and 0.75 min., respectively.

Based on limited data, a space of 0.031 in. was recommended by Finney and Shogren (1972) for the 10g Mixograph. That space is corroborated by the 0.033 in. for the 5g instrument. Therefore, a recommended space of 0.033 ± 0.002 in. is recommended for all Mixographs.

**MIXER SPEED (RPM)**

Baig and Hoseney (1977) studied by response surface methods the effect of Mixograph speed on peak mixing time. Three flours with medium mixing requirements and various protein contents, and a fourth with a long peak time were used. Mixograph head speed was varied from 70 to 170 rpm (normal 88 rpm). As expected, increasing the mixer speed decreased peak time, but the effect was less pronounced at high than at low speeds.

**CERTAIN COMPOUNDS**

One winter wheat flour and three spring wheat (Red River 68) flours with long mixing requirements were used to study the effects when cysteine hydrochloride was added at 0 to 120 ppm (Finney et al. 1971). For one spring wheat flour, 40, 80, and 120 ppm reduced peak mixing time from 5.63 min to 3.50, 2.75, and 2.38 min, respectively (Fig. 12). Thus, the mixing and other physical dough properties of long-mixing-time flours can be converted readily and instantaneously to desirably shorter mixing requirements and relatively mellow dough-handling properties.

Weak et al. (1977) used the Mixograph to study the effects of oxidants, sulfhydryl-containing reagents, compounds containing activated double bonds, and ascorbic acid on dough properties. Cysteine's effect was compared with those of other reducing compounds. Fumaric acid and related unsaturated compounds reduced mixing time, but caused rapid dough breakdown and thinning of the mixogram's tail. The action of N-ethylmaleimide, a sulfhydryl-blocking reagent, was similar to that of fumaric acid. Oxidants normally used in bread baking did not affect mixing time but the fast-acting oxidants ($KIO_3$ azodicarbonamide, and $KBrO_3$ at pH 4.7) gave rapid dough breakdown and an extremely narrow mixogram tail. Slower-acting oxidants (ascorbic acid and $KBrO_3$ at pH 6.0) had little effect on the mixograms. The results did not confirm reports that ascorbic acid reduced mixing time in oxygen-limiting atmosphere. However, ascorbic acid in a $CO_2$ atmosphere did cause lower mixogram peak heights. Fast-acting oxidants were shown to interact with sulfhydryl compounds, which negated their effect on mixing (Weak et al. 1977).

**ABSORPTION DETERMINATION**

As protein content increases within a cultivar, water absorption increases (Fig. 13). The regression lines in Figure 13 form a fan-shaped family of lines that show the quality differences in water absorption at any given protein content (Finney et al. 1987). Thus, water absorption is a function of the quantity and quality of wheat flour proteins.

The data in Figure 13, together with similar, more recent, but unpublished data on many other cultivars of wheat are the basis for a similar update family of regression lines. The following equations are for those who wish to reproduce the updated figure on cross-section paper: $Y = mX + b$. Where, Y = mixogram flour absorption (14% mb) and X = flour protein content (14% mb). Given the values m = 1.5 and b = 43, with increases or decreases in m represented by $\Delta m$ in the formulas becomes:

$$Y = 1.5X + 43;$$
$$Y = (1.5 + \Delta m)X + 43 - 4.6666\ \Delta m$$
$$Y = (1.5 - .\Delta m)X + 43 + 4.6666\ \Delta m$$

When reproducing the updated figure, allow flour protein content to vary from 10 to 18% and slope from 0 to 2.1. The regression lines are curvilinear below about 10% protein and probably meet at 0% protein and 50% flour absorption.

Working, or "as received" flour absorption is a function of protein content, cultivar, flour moisture, and environment. Preliminary mixogram absorption is determined with the aid of the data in Figure 13 or the updated figure for which equations have been given. Thereafter, final absorption is determined with the aid of Figures 4 and 5. Protein and moisture contents of all flours are required.

For example, the first of a group of diverse hard wheat progenies has a moisture content of 12.6% and a protein content of 13.3% (14% mb). Then, 13.3% on the Kharkof (Kk) regression line (1.5 slope on updated figure) corresponds to 63.0% absorption (14% mb); and 63.0 + (100 - 98.4) = 64.6% “as received" preliminary mixogram absorption; 98.4g of flour at 12.6% moisture is equivalent to 100g of flour on a 14% mb. Preliminary mixogram absorptions of the other flours in the group would be calculated in a similar manner, based on their protein and moisture contents. After all "as received" preliminary absorptions are calculated, mixograms would be recorded. The "as received" absorption of each sample could be increased, decreased, or remain unchanged as the final mixogram absorption after comparison with the appropriate mixogram in Figures 4 and 5. Assume that the preliminary "as received" absorption of 64.6 was 1.5% stiff, based on the data in Figures 4 and 5. Then the adjusted "as received" absorption would be 64.6 + 1.5 = 66.1%, and the adjusted absorption on a 14% mb would be 66.1 - 1.6 = 64.5%.

When a number of sister progenies (say 20) are involved, 2g of each are blended to give 40g of flour for the determination of the preliminary mean "as received" mixogram absorption followed by the adjusted mean absorption on a 14% mb. Thereafter, the regression line representing the adjusted mean absorption (14% mb) can be selected and applied to each sister based on their protein and moisture contents. Thus, the preliminary mixogram absorption of a flour should be estimated by plotting the protein content (14% mb) of the flour on the Kharkof (Kk) regression line (Fig. 13). That absorption, after correcting to the "as received" moisture basis is used to record the mixogram, which is adjusted from the mixogram appearance (degree of stiffness or slackness) in Figures 4 and 5. One mixogram often is sufficient. Only occasionally is it necessary to record more than two mixograms. That method has been used successfully for

many years at the HWW Quality Laboratory in the U.S. GPMR Center, Manhattan, KS.

**FUNCTIONAL PROPERTIES**

Either the 5g or 10g Mixograph is a candidate for the single most useful instrument for determination and prediction of functional (breadmaking) properties of early generation plant breeders lines (Table 4). Table 4 is a revision of a similar table presented by Finney and Shogren (1972).

**REFERENCES**


Baig, M. M., and Hoseney, R. C. 1977. Effects of mixer speed, dough temperature, and water absorption on flour-water mixograms. Cereal Chem. 54(3):605-615.

Finney, K. F. 1989. A five-gram Mixograph to determine and predict functional properties of wheat flours. Cereal Chem. 66(6):527-530.

Finney, K .F., and Shogren, M. D. 1972. A ten-gram Mixograph for determining and predicting functional properties of wheat flours. Bakers Digest 46(2):32-35, 38-42, 77.

Finney, K .F., Tsen, C. C., and Shogren, M. D. 1971. Cysteine's effect on mixing time, water absorption, oxidation requirement, and loaf volume of Red River 68. Cereal Chem. 48(5):540-544.

Finney, K .F., Yamazaki, W. T., Youngs, V. L., and Rubenthaler, G. L. 1987. Quality of hard, soft, and durum wheats. Pages 677-748 in: Wheat and Wheat Improvement. E. G. Heyne, ed. Am. Soc. Agr. Inc.: Madison, WI.

Weak, E. D., Hoseney, R. C., Seib, P. A., and Baig, M. 1977. Mixograph studies. I. Effect of certain compounds on mixing properties. Cereal Chem. 54(4):794-802.


## TABLE 1

### Flour Protein Content, Absorption, and Mixing Times for Four Cultivars Using the 5- and 10-g Mixographs

| Cultivar | Flour Protein (%) | Mixo. Abs. (%) | Mixogram Time to Peak (min) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Rep 1 | | Rep 2 | | Rep 3 | |
| | | | 5-g | 10-g | 5-g | 10-g | 5-g | 10-g |
| A | 13.4 | 65.6 | 6.00 | 6.13 | 5.88 | 6.00 | 6.00 | 6.00 |
| B | 14.4 | 66.4 | 1.50 | 1.63 | 1.75 | 1.75 | 1.63 | 1.63 |
| C | 18.6 | 71.6 | 4.25 | 4.25 | 4.38 | 4.25 | 4.50 | 4.13 |
| D | 8.7 | 59.5 | 6.38 | 6.50 | 6.50 | 6.50 | 6.63 | 6.50 |

Data are on a 14% mb.

## TABLE 2

### Analysis of Variance for Mixing Times for Four Cultivars Using the 5- and 10-g Mixographs

| Source of Variation | df | Sum of Squares | Mean Squares | F-Value |
|---|---|---|---|---|
| Size ( S ) | 1 | 0.0007 | 0.0007 | (0.08) P > 0.20 |
| Cultivar ( C ) | 3 | 86.3509 | 28.7837 | (3401.0) P < 0.001 |
| S X C | 3 | 0.0540 | 0.0180 | (2.13) 0.20 > P > 0.10 |
| Samples ( S, C ) | 16 | 0.1354 | 0.0085 | |
| Total | 23 | 86.5410 | | |

# TABLE 3

## Comparison of Flour Blends Using the 5- and 10-g Mixographs

| Flour Blend (%) | Protein (%) | Abs. (%) | Time to Peak (min) | |
|---|---|---|---|---|
| | | | 5-g | 10-g |
| Cultivar A:B | | | | |
| 100:0 | 13.4 | 65.6 | 6.13 | 6.00 |
| 75:25 | 13.7 | 65.8 | 4.75 | 4.75 |
| 50:50 | 13.9 | 66.0 | 3.88 | 3.63 |
| 25:75 | 14.2 | 66.2 | 2.63 | 2.75 |
| 0:100 | 14.4 | 66.4 | 1.63 | 1.63 |
| Cultivar C:D | | | | |
| 100:0 | 18.6 | 71.6 | 4.25 | 4.25 |
| 75:25 | 16.1 | 68.6 | 4.88 | 4.75 |
| 50:50 | 13.7 | 65.6 | 5.38 | 5.25 |
| 25:75 | 11.2 | 62.5 | 6.00 | 6.00 |
| 0:100 | 8.7 | 59.5 | 6.50 | 6.50 |

Date are on a 14% mb. Protein contents and absorptions were calculated based on % components in the blend.

Cultivars A:B were blended for ranges in mixing times.

Cultivars C:D were blended for ranges in protein content.

# TABLE 4

## Categorization of Physical Dough Properties Related to Mixing Requirements and Tolerances

| Mixing Time (min) | Mixing Tolerance | Physical Dough Properties | Dough Handling | Water Requirement | Bromate Requirement | Loaf Volume |
|---|---|---|---|---|---|---|
| 5.25 - 7.25 (long) | ≥ Good | Very strong to bucky | ___ | ≥ Good | Small | ≥ Good |
| 3.75 - 4.75 (medium-long) | ≥ Good | Strong | Good | ≥ Good | Med-Small | ≥ Good |
| 2.75 - 3.25 (medium) | Fair to Good | Mellow to Medium Strong | Fair to Good | Good | Medium | ≥ Good |
| 1.75 - 2.25 (short) | Poor to Fair | Weak to Mellow | Poor to Fair | Poor to Good | Med-Large | Poor to Good |
| 1.0 - 1.5 (very short) | Very Poor to Poor | Very Weak to Weak | Very Poor to Poor | Very Poor to Fair | Large | Very Poor to Fair |

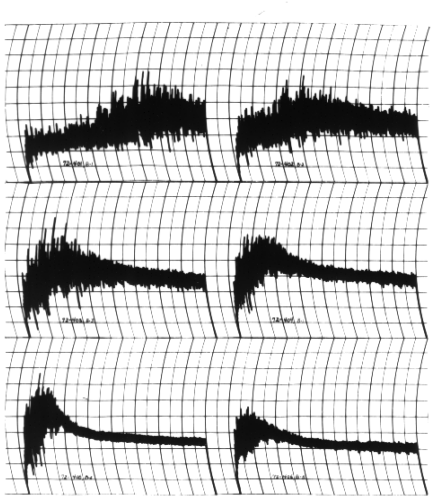


Fig. 1 Typical mixograms of hard winter wheat flours (10g) that contained about 12% protein and vary in mixing requirement and mixing tolerance. Major arcs are at 1-min intervals.

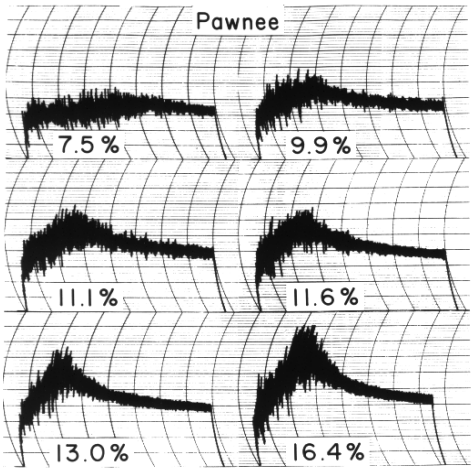



Fig. 2 Effect of flour protein content on mixing properties of Pawnee, a short-mixing HWW flour.

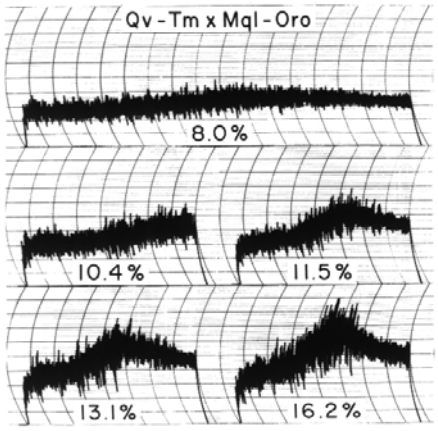



Fig. 3 Effect of flour protein content on mixing properties of Quivira/Termarq/Marquillo/Oro, a medium-long mixing HWW flour.

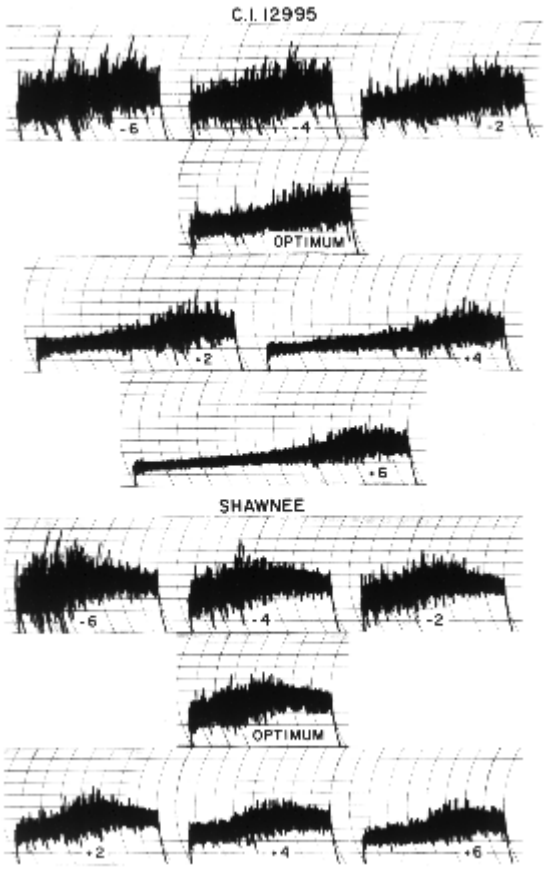



Fig. 4 Effect of decreasing and increasing water absorption from optimum on 10g mixogram characteristics of C.I.12995 and Shawnee, HWW flours.

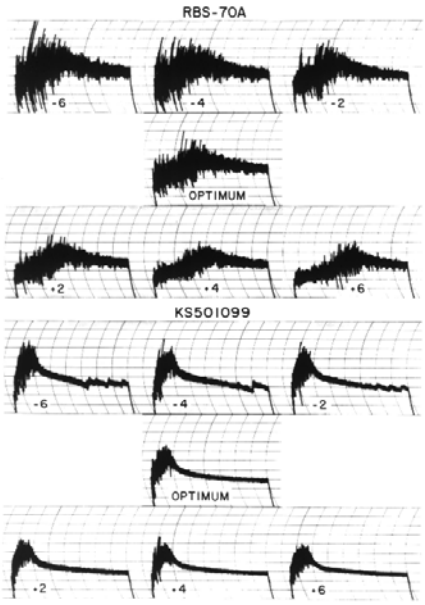



Fig. 5 Effect of decreasing and increasing water absorption from optimum on 10g mixogram characteristics of RBS-70A and KS501099, HWW flours.

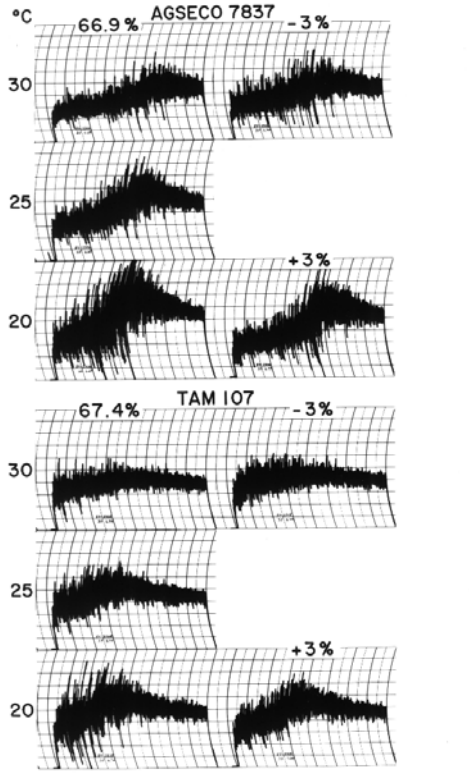



Fig. 6 Effect of temperature on mixogram characteristics.

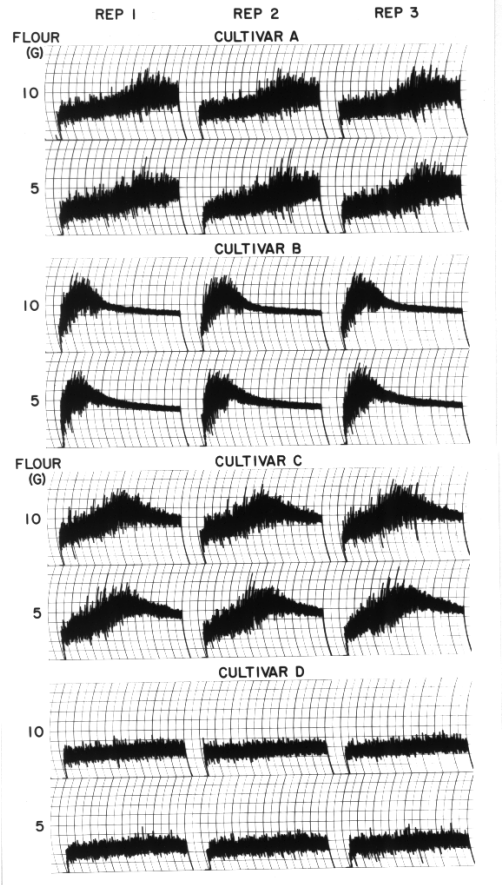



Fig. 7 Mixograms of cultivars A, B, C, and D each run three times on the 5- and 10g Mixographs (Table 1).

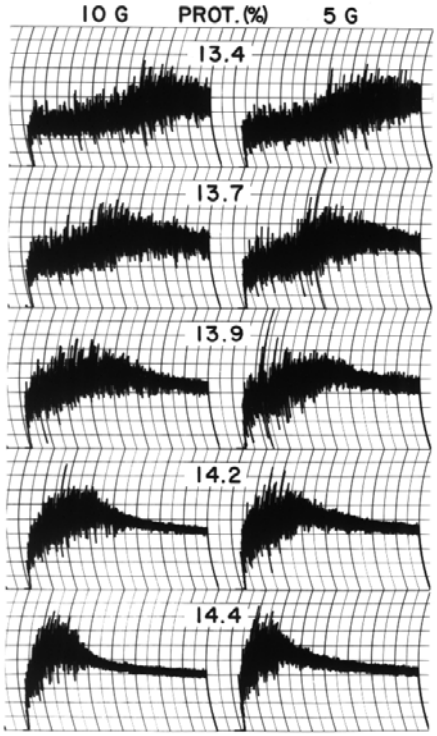



Fig. 8 Mixograms (5- vs. 10g) of cultivars A (top) and B (bottom) and their 75:25, 50:50, and 25:75 flour blends made to give a range in mixing time to peak (Table 3, top).

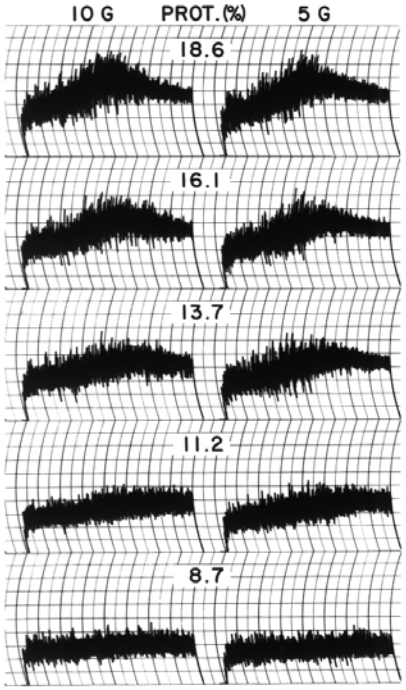



Fig. 9 Mixograms (5- vs. 10g) of cultivars C (top) and D (bottom) and their 75:25, 50:50, and 25:75 flour blends made to give a range in flour protein content (Table 3, bottom).

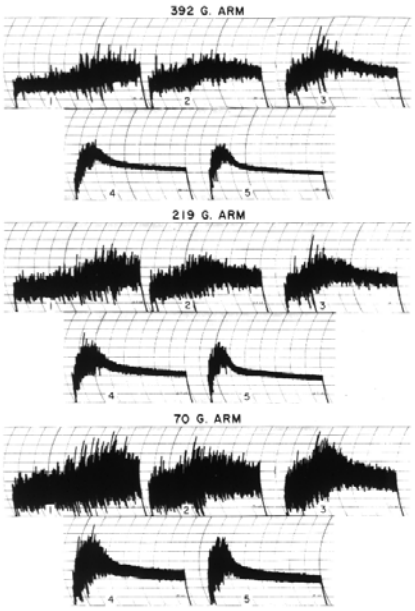



Fig. 10 Effect of arm weight on 10g mixogram width.

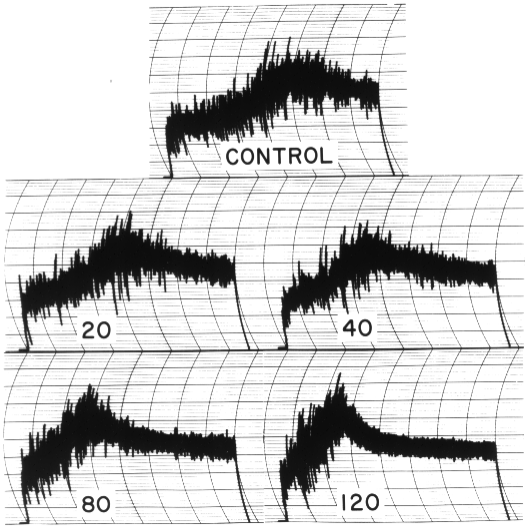



Fig. 12 Effect of cysteine hydrochloride (ppm) on peak time and on other mixogram properties of the Red River 68 flour that contained 13.5% protein.

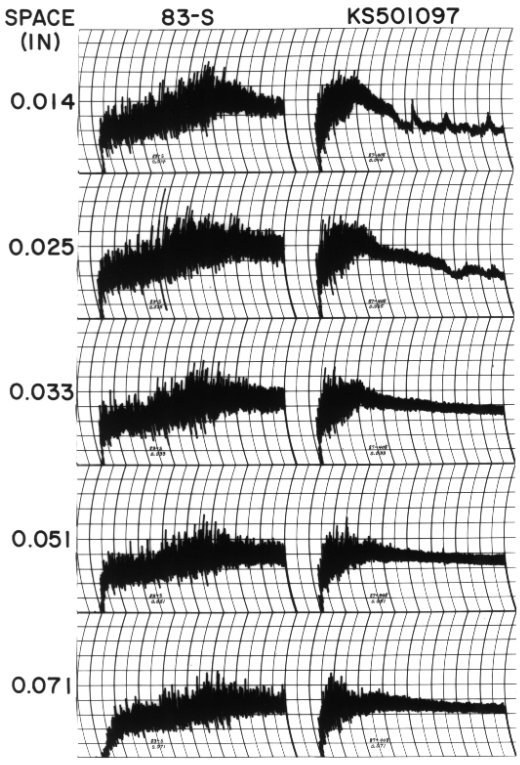



Fig. 11 Effect on mixogram characteristics of varying the space between planetary pins and bottom of bowl.

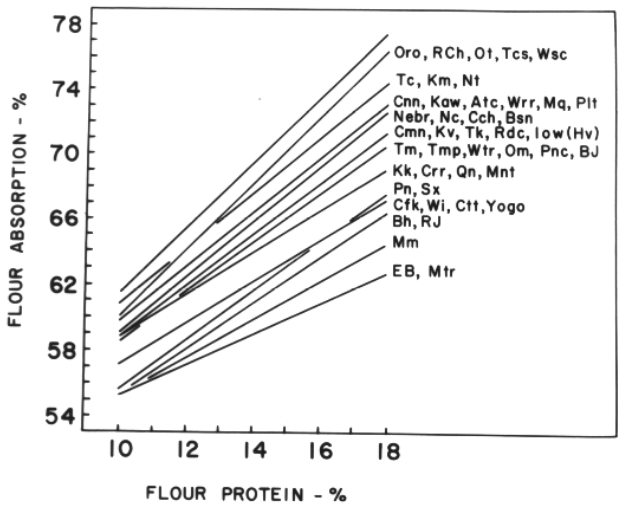



Fig. 13 Flour absorption vs. protein content regression lines for 42 hard winter and 3 hard spring wheat cultivars. Each cultivar regression line represents 25 to 100 samples harvested throughout the Great Plains during several crop years. Occasionally, experimental progenies fall on the top line or below the bottom line.

# Chapter 6
# MIXOGRAM MEASUREMENTS AND OBJECTIVE ABSORPTION DETERMINATION

J. L. Hazelton and C. E. Walker

Dept. of Grain Science and Industry, Kansas State University, Manhattan, KS, USA

## MIXOGRAM MEASUREMENTS

The Mixograph output is referred to as a mixogram. Electronic acquisition and analysis of mixograms by the computer has resulted in less subjective and tedious methods compared to the conventional (manual) methods of data collection and interpretation (Gras et al. 1990). Although variability between the two methods exists, the underlying basis for mixogram analysis is still the same.

The software calculates a smoothed mixing curve and derives approximately 40 separate measurements for each curve (Walker and Walker 1990, Wooding and Walker 1992). Both midline and envelope (curves defining the center top and bottom of the mixogram) analyses are produced. The peak times and heights, ascending and descending slopes (left and right of peak), band widths, and curve areas (representing work input) are evaluated (Fig. 1). The peak times are expressed in minutes. Heights and bandwidths are expressed as a percent of full-scale torque values. Slopes are expressed as the change in percent height divided by time. The area (work function) is expressed as an integral of percent torque multiplied by time. Although the software normally calculates a smoothed mixing curve and automatically selects the peak, the analysis can be influenced by manually selecting the midline peak.

## ABSORPTION EFFECTS

Peak time and height is determined primarily by the flour's protein content and secondarily by the water absorption (Swanson and Johnson 1943). Knowing three factors, flour protein, moisture content, and the wheat variety from which the flour was milled, a skilled operator can apply Finney's equation to predict Mixograph absorption (Finney 1945, AACC 1991).

Absorption influences the dough stiffness and hence the work required to mix the dough. Curve width, especially in the ascending portion of the curve, is also affected by absorption. Flours mixed with insufficient absorption produce mixograms with short mixing times, and increased peak heights, work inputs (area under the curve), and band widths, resulting in a "wild" appearance (Swanson and Johnson 1943, Finney and Shogren 1972). The opposite results occur with excessive absorption. The ascending slope is an indication of the rate of dough development and the descending slope is associated with the rate of dough breakdown (weakening or dough stability). The weakening slope is related to the variety and protein content of the flour. The flatter the angle between the developing and weakening slopes, the greater the mixing tolerance. The degree of 'sway-back' character of the ascending curve and the mixogram height on the scale are also influenced by absorption.

## ABSORPTION DETERMINATION

Although the Mixograph has been used for many years, its use is still limited by a subjective absorption determination. Under uniform conditions in any one laboratory, usable replication can be obtained, but the variability is high between laboratories (Kunerth and D'Appolonia 1985). Some workers have used a fixed absorption, whereas others use an absorption based on flour moisture and protein (Finney 1945). Yet another method requires the user to adjust absorption based on multiple trial curves. More information on determining Mixograph absorption by this method can be found in Chapter 2, *Comparison of Two Recording Dough Mixers: The Farinograph and Mixograph* by M. E. Ingelin.

Selecting the proper absorption when using direct-drive or fixed-bowl Mixographs is even more difficult because of the rather wide curves resulting from the increased sampling sensitivity (Rath et al 1990). However, there are still changes in the ascending curve "sway-back", the overall "wildness", the overall mixogram height, and the band width at various points. Hence, some combination of measurements might indicate whether or not the initial or trial absorption was correct and, if not, to predict an adjustment. Therefore, the objective was to develop a regression equation to predict proper Mixograph absorption based on moisture and protein analysis and the results from a single Mixograph trial.

*Materials and Methods*

Flour samples (156) with various mixing characteristics having protein contents ranging from 8.75 to 15.86% were collected from six sources throughout the US. Moving bowl mixograms were run and absorptions subjectively determined in the usual manner.

Two 2-gram direct drive Mixographs (National Mfg. Div. of TMCO, Lincoln, NE) were then used to test all 156 flours. An absorption series was run for each flour, using the "proper" absorption as the starting point, and then adjusting it ± 3% for a total of 468 mixograms.

*Results*

A multiple second order regression equation was developed that related absorption to peak height (ph), width at 55%-of-peak-time (55w), tail integral (ti), protein (prot), sway factor (sf), peak width (pw), and envelope-area integral (ai). When trial mixogram values are entered, the equation will predict a percent absorption adjustment (% Abs Adj) necessary to correct the starting absorption.

% Abs Adj = – 1.601 – 1.417 (ph) + 1.527 (55w) + 0.083 (ti) + 0.050 (prot)(sf) + 0.047 (prot)(ph) – 0.134 (prot)(55w) + 0.112 (ph)(pw) + 0.065 (ph)(55w) – 0.0093 (ph)(ti) +

0.096 (pw)(55w) + 0.00041 (ti)(ai) – 0.026 ($sf^2$) – 0.059 ($pw^2$) + 0.00042 ($ti^2$)

The regression equation accounts for about 60% of the deviation ($r^2$=0.595 and a standard error of 1.79%). Analysis of variance for the multiple regression equation yielded an F value of 47.57. The starting absorption is a good estimation of the "proper" Mixograph absorption. It is based on protein quantity and may not take into account other flour characteristics such as protein quality, the amount of starch damage, or fiber content, all of which affect absorption. This equation helps to adjust for these uncontrolled variables.

*Applying the Method*

In order to use the equation for the 2-gram machine, first run a mixogram with a trial absorption based on protein content, where % Abs = 1.5 × %protein + 43.6, with all calculations and weights based on 14% moisture (Finney 1945 and AACC 1991). Then, using the above equation, calculate an absorption adjustment. As long as the adjusted absorption is within ± 3.5% of the actual absorption that was run, accept the correction and proceed. If the recommended adjustment exceeds 3.5%, make the adjustment and repeat the test with the new starting point. Do not expect to get a "zero" recommended adjustment, and repeated iterations are pointless. Few operators can consistently determine changes of less than 2% in absorption because those changes are smaller than the random variations between replicate mixograms.

*Conclusions*

This method relies less upon operator experience than earlier techniques. The equation could be useful for routine Mixograph analysis, as by plant breeders running large numbers of samples with the 2-gram machine, especially when they must screen many samples rapidly. An adjustment for "dry" or "wet" preferences requires only an adjustment to the equation's first term constant. A collaborative study to develop a prediction model for the 10- and 35-gram models is currently underway (Hazelton and Walker 1997).

**REFERENCES**


American Association of Cereal Chemists. 1991. Approved Methods of the AACC, 8th ed. Method 54-40A, approved 4-61, revised 10-88. The Association: St. Paul, MN.

Finney, K. F. 1945. Methods of estimating and effects of variety and protein content level on the baking quality of flour. Cereal Chem. 22:149-160.

Finney, K. F. and Shogren, M. D. 1972. A ten-gram Mixograph for determining and predicting functional properties of wheat flours. Baker's Digest 46:32-42, 77.

Gras, P. W., Hibberd, G. E., and Walker, C. E. 1990. Electronic sensing and interpretation of dough properties using a 35-g Mixograph. Cereal Foods World 35(6):568-571.

Hazelton, J. L. and Walker, C. E. 1997. An objective method for predicting moving bowl Mixograph absorption. Cereal Foods World 42(8):614 – abstract #76.

Kunerth, W. H. and D'Appolonia, B. L. 1985. Use of the Mixograph and Farinograph in wheat quality evaluation. Pages 27-49 in: Rheology of Wheat Products. H. Faridi, ed. Am. Assoc. Cereal Chem.: St. Paul, MN.

Rath, C. R., Gras, P. W., Wrigley, C. W., and Walker, C. E. 1990. Evaluation of dough properties from two grams of flour using the Mixograph principle. Cereal Foods World 35:572-574.

Swanson, C. O. and Johnson, J. A. 1943. Description of mixograms. Cereal Chem. 20:39-42.

Walker, C. E. and Walker, A. E. 1990. Mixograph data acquisition and analysis by personal computer. Cereal Foods World. 35:823. (Abstract).

Wooding, A. R. and Walker, C. E. 1992. Comparison of alternative recording mechanisms (mobile vs. fixed-bowl) for the 35- and 10-gram Mixographs. Cereal Chem. 69(3):249-253.

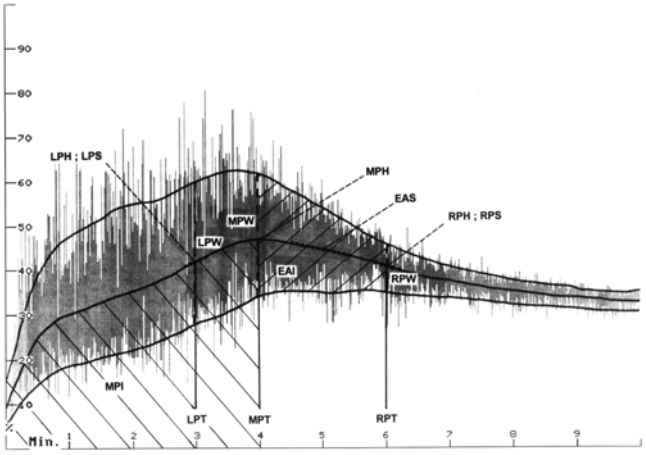




Fig. 1 Typical mixogram identifying curve locations where measurements are often taken.

MP = Midline Peak
MPT – Peak Time (min)
MPH – Peak Height (% of scale)
MPW – Peak Width (% of scale)
MPI – Peak Integral (%tq*min)

LOP = Left-of-Peak (midline)
LPT – LOP Time (min)
LPH – LOP Height (% of scale)
LPS – LOP Slope (%/min)
LPW – LOP Width (% of scale)

ROP = Right-of-Peak (midline)
RPT – ROP Time (min)
RPH – ROP Height (% of scale)
RPS – ROP Slope (%/min)
RPW – ROP Width (% of scale)

EA = Envelope Area
EAS – EA Slope (%/min)
EAI – EA Integral (%tq*min)

TX = variable location that can be:
- a particular time (8 min)
- a relative time to MP (MP+3 min)
- a fraction of MP (MP*0.55)

TXT – TX Time (min)
TXH – TX Height (% of scale)
TXS – TX Slope (%/min)
TXW – TX Width (% of scale)
TXI – TX Integral (%tq*min)

# Chapter 7
# TEMPERATURE AND THE MIXOGRAPH

K. Shelke, A. Li, J. L. Hazelton, and C.E. Walker

Dept. of Grain Science and Industry, Kansas State University, Manhattan, KS, USA

## HOW TEMPERATURE AFFECTS MIXING

Unlike other recording dough mixers, no provisions were made for temperature control in the bowl. Though for years some of the instruments were housed in cabinets that had been equipped with simple heater/fan/cooling coil arrangement in an attempt to control the air temperature. However, many workers removed the instrument from the cabinet. As early as 1944, Harris and coworkers (1944) recognized that the temperature at which mixograms were made had an important effect on curve properties. They reported that change in temperature caused greater variations in the mixograms of hard red spring wheat flours than different protein contents. Baig and Hoseney (1977) observed decreased curve height and increased mixing time with increases in dough temperature within a narrow range of 25-40° C.

Swanson and Working (1933) used the recording dough mixer (Mixograph predecessor) to test the effect of water at three different temperatures on curve properties and reported differences in curve characteristics. It is humbling to note that they were aware of the same concerns we have today, yet discouraging that no progress has been made in that direction. Despite a study in 1950 by Heizer and co-workers (1951), in which temperature fluctuation was identified as the chief source of variation within a laboratory and in interlaboratory collaborative work, no concerted effort has been made towards Mixograph temperature control.

## PART I. A WATER-JACKETED BOWL

The objectives of this study were to use a water-jacketed bowl to document the effect of dough temperature on mixogram curve height and peak time. A hard red winter (moisture 14.0%, protein 13.7%, ash 0.46%) flour was used. The 10g Mixograph (National Mfg. Div., TMCO Inc., Lincoln, NE) was equipped with a customized bowl for this study. Lightweight tubing was used to circulate water from a refrigerated water bath to maintain bowl temperature. Flour-water mixograms were obtained at six temperatures in which the bowl and water temperatures were varied from 10° to 60° C at 10° C intervals. The water absorption level was kept constant at the "normal" value determined for the flours at 25□C. The dough was mixed for 10 min and dough temperature was recorded at the end of mixing using a fine-point electronic thermometer. Mixing data were collected by a computerized moving-bowl Mixograph as described by Neufeld and Walker (1990).

### *Dough Temperature and Appearance*

Dough temperature was taken at the end of mixing and plotted against bowl temperature (Fig. 1). The deviation is sigmoid, with greater deviations from the theoretical at the range extremes. Accordingly, final dough temperature rather than bowl temperature was used for the reference point. Dough surfaces appeared increasingly glassy with increasing bowl temperature indicating loss in water holding ability.

### *Mixogram Curve Height and Peak Time*

Mixogram curve height was inversely affected by dough temperature; as dough temperature increased, curve height and band width decreased (Figs. 2 and 3). As dough temperature increased, mixogram peak time also increased (Fig. 4). At 50° and above, the characteristic peak tended to disappear.

As bowl temperature was increased by 5° C from 25° C, curve height decreased by 5% and peak time increased by 15 sec. Decreasing the dough temperature by 5° C from 25° C caused a 6% increase in curve height and a 25 sec decrease in peak time. This illustrates the importance of temperature control, especially when Mixograph data from several locations are to be compared. (For additional details see Shelke and Walker 1990).

## PART II. TEMPERATURE CHANGE DURING MIXING

Jacketed bowls to control dough temperature during mixing, have limited success (Shelke and Walker 1990). The inability of the bowl to remove the heat generated during mixing is probably due to the poor thermal conductivity of the dough and its limited contact with the bowl bottom. During mixing, the dough forms a "pillar" (Fig. 5) between a small part of the bowl bottom and the dough guard on the rotating mixer head. Note that a mixing dough does not contact the bowl sides. The temperature near the center of the dough pillar will to be more affected by flour and water starting temperatures, hydration, and work input during mixing, than by the bowl or room temperatures. One of the questions remaining unanswered by the preceding section is how dough temperature changes during mixing. In addition, the heat capacity and thermal conductivity of the bowl and mixing head may have as much influence on mixograms as does the environmental conditions.

### *Mixing and Temperature Recording*

Mixing was done on a 35g moving-bowl Mixograph (National Mfg. Div., TMCO Inc., Lincoln, NE) connected to a computer that automatically collected the data and calculated the mixing parameters (Gras et al 1990, Walker and Walker 1990). Two bowls, one aluminum and the other Plexiglas, were used to measure dough temperature during mixing. Each bowl had a type K thermocouple was mounted inside the front bowl pin. A datalogger recorded dough temperatures to the nearest 0.1° C at 1 sec intervals during mixing.

High-gluten flour was diluted with wheat starch so that the net protein content was reduced incrementally from 14.45 to 8.26% (14% mb). Water absorption level was calculated according to the equation: % absorption = (1.5 x protein %) + 43.6 (Finney 1945, AACC 1991). Flour-water mixograms were recorded at room temperature (24-26° C) with equipment and ingredients starting at room temperature.

***Mixing Temperature Curves***

In a mixogram (Fig. 6A), the cross-hatched area beneath the curve midline between 1 min left of peak and 2 min right of peak is proportional to the work input during that time. Figure 6B is the curve of dough temperature vs. mixing time, taken simultaneously with Fig. 6A. Four relatively distinct regions in the temperature change curve can usually be identified. In region I, the temperature rises by about 3.5° C during the first 10-15 sec. Region II has a much slower temperature increase for an additional 2-3 min. In region III, the curve follows an almost straight line, with a much steeper slope than in region II. The slope in region III decreases with lower protein contents. This region typically lasts 3-4 min and corresponds to the peak and widest part of the mixogram. The mixogram midline peak seems to occur at the center of region III. Region IV shows a slower temperature increase during the last 2-3 min. It is not always linear or as well defined as that of region III.

When water is quickly added to the flour, the flour particle surfaces rapidly hydrate (Hoseney and Finney 1974) and the dough temperature rises rapidly (region I). When flour is diluted with starch, this region in the curve shows relatively little change.

As mixing proceeds the free water is gradually absorbed and the protein begin to develop into a partially elastic but still flowable gluten. The temperature profile is relatively flat (region II). When high-gluten flour was diluted with starch, region II was shortened. When salt was added to high-gluten flour, however, region II persisted longer, indicating that salt had delayed protein development. Salt also caused an increase in the slope of region III, indicating that more work was required to develop the dough. As mixing continues, the dough develops, requiring more mechanical work. During this stage, the temperature curve (region IV) shows an increase related directly to increasing protein concentration.

A good correlation between the region III temperature increase rate (slope) and the Mixograph work input (area under the curve) was also found. The mixogram peak time corresponds to the center of region III of the temperature curve, and the average peak height correlates with the region III slope.

The temperature continues to increase, passing the peak time, until the break point of the mixogram curve slope is reached (MR, Fig. 6A). After this, the increasing temperature rate slows and enters region IV. This region has the same curve shape as a purely viscous system (e.g., a silicon oil mixture). At this stage, the dough is badly overmixed; it has lost much of its elastic property and has become a wet, sticky mass. (For additional details see Li and Walker 1992).

***Bowl Material***

The materials that comprised the bowls (aluminum or Plexiglas) had a significant affect on both the mixing and temperature profiles. The Plexiglas bowls produced straighter, higher temperature curves, which lacked inflection points (Fig. 7). This may be expected, as the aluminum is an excellent conductor of heat while Plexiglas is not. Aluminum's heat capacity is also larger than that of Plexiglas. The overall average dough temperature rise in the aluminum bowl was about 2.0° C, whereas in the Plexiglas bowl, the rise was 3.0° C. The mixing action may be affected due to the differences in surface texture of the two materials, or it may be because the aluminum bowl acted as a heat sink to remove heat from the fixed pins. It was found that the temperature rate increased much faster than the actual work input (peak integral), which changed only 1%. In addition, the aluminum bowl required a higher work input than the Plexiglas bowl. Therefore, it was concluded that the metal bowl did act as a heat sink. (For additional information see Hazelton and Walker 1995).

**PART III. DOES BOWL POSITION AFFECT DOUGH HEATING RATE?**

The relative position of the bowl during mixing does affect the relationship (spacing) between the head and bowl pins. The objectives of this study were to observe the relative effects of temperature rise during mixing of flour-water doughs at various bowl positions, and correlate these temperature changes with mixogram values.

A 35g, fixed-bowl, computerized Mixograph (National Mfg. Division, TMCO Inc., Lincoln, NE) was used. Bowl position was determined by the alignment of the recording pen used for the moving-bowl configuration, with the 0% and 100% pen positions representing the minimum and maximum rotation range (~38°). Mixograms were run at five fixed-bowl positions (10%, 30%, 50%, 70%, and 90% pen positions) while simultaneously measuring dough temperature. Dough temperature and mixing torque were electronically collected and analyzed.

The mixing results were significantly affected by varying the bowl position. More information on this subject can be obtained from Chapter 8, *Mixograph Pin Paths and Points of Minimum Clearance* by Walker and Hazelton. Peak time decreased and peak height and integral (work) increased as bowl position was increased. Dough temperatures were also affected by changes in bowl position. The overall height of the temperature curves increased as the bowl was rotated from the 10% to 90% pen position. As reported by Li and Walker (1992), who used the conventional, moving-bowl Mixograph, we also observed that the dough temperature rise during mixing matched the mixogram.

**CONCLUSIONS**

Starting temperature has a profound effect on mixograms. Also, the dough's temperature changes during mixing and this temperature change can be correlated with mixogram values. The relative position of the bowl and head pins also affects temperature rise during mixing and is at least partially responsible for the different mixing curves.

**REFERENCES**

American Association of Cereal Chemists. 1991. Approved Methods of the AACC, 8th ed. Method 54-40A, approved April 1961, revised October 1988. The Association: St. Paul, MN.

Baig, M. M. and Hoseney, R. C. 1977. Effects of mixer speed, dough temperature, and water absorption on flour-water mixograms. Cereal Chem. 54(3):605-615.

Finney, K. F. 1945. Methods of estimating and the effect of variety and protein level on the baking absorption of flour. Cereal Chem. 22(2):149-158.

Gras, P. W., Hibberd, G. E., and Walker, C. E. 1990. Electronic sensing and interpretation of dough properties using a 35-g Mixograph. Cereal Foods World. 35(6):568-571.

Harris, R. H., Sibbitt, L. D., and Scott, G. M. 1944. The effect of temperature differences on some mixogram properties of hard red spring wheat flours. Cereal Chem. 21(5):375-385.

Hazelton, J. L. and Walker, C. E. 1995. Measuring temperature rise during mixing at various Mixograph bowl positions. National Notes 2(3):2-6.

Heizer, H. K., Moser, L., Bode, E. E., Yamazaki, W. T., and Kissell, L. T. 1951. Studies concerning Mixograph standardization. Transactions of the Am. Assoc. of Cereal Chem. 9:16.

Hoseney, R. C. and Finney, P. L. 1974. Mixing--A contrary view. Baker's Dig. 48(1):22.

Li, A. and Walker, C. E. 1992. Dough temperature change during mixing in a Mixograph. Cereal Chem. 69(6):681-683.

Neufeld, K. J. and Walker, C. E. 1990. Evaluation of commercial wheat gluten using the Mixograph. Cereal Foods World 35(7):667-669.

Shelke, K. and Walker, C. E. 1990. A water-jacketed bowl for Mixograph temperature control. Cereal Foods World 35(6):575-577.

Swanson, C. O. and Working, E. B. 1933. Testing the quality of flour by the recording dough mixer. Cereal Chem. 10(1):1-29.

Walker, C. E. and Walker, A. E. 1990. Mixograph data acquisition and analysis by personal computer. (Abstr. #95). Cereal Foods World 35:823.

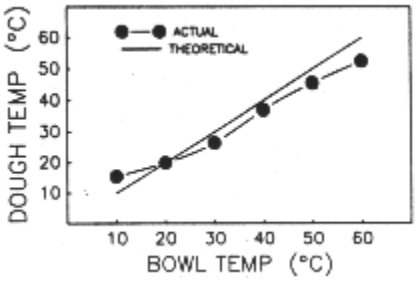



Fig. 1 Dough temperature as a function of Mixograph bowl temperature.

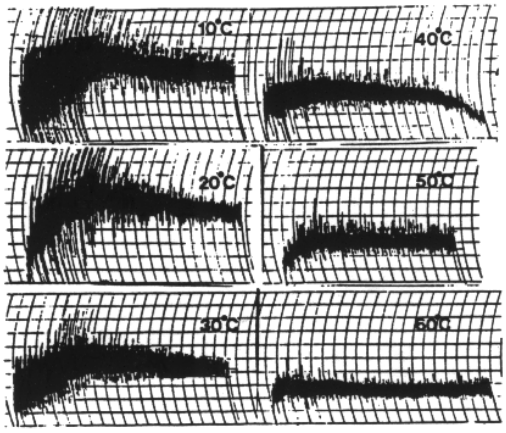



Fig. 2 Mixograms taken over a bowl temperature range of 10°-60°C.

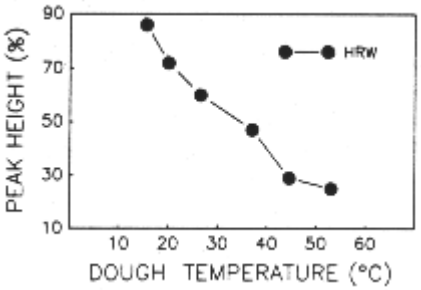



Fig. 3 Mixogram peak height as a function of dough temperature.

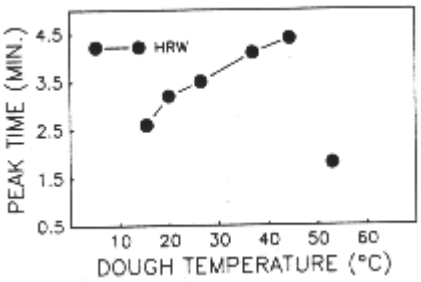



Fig. 4 Mixogram peak time as a function of dough temperature. Data points for 60°C are not connected to those for 50°C to emphasize that a continuum in behavior is not necessarily present. A true peak was difficult to identify at 60°C.

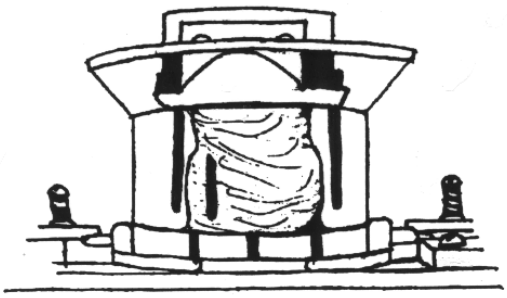


Fig. 5 Dough forms a 'pillar' during mixing, and does not normally touch the mixing bowl sides.

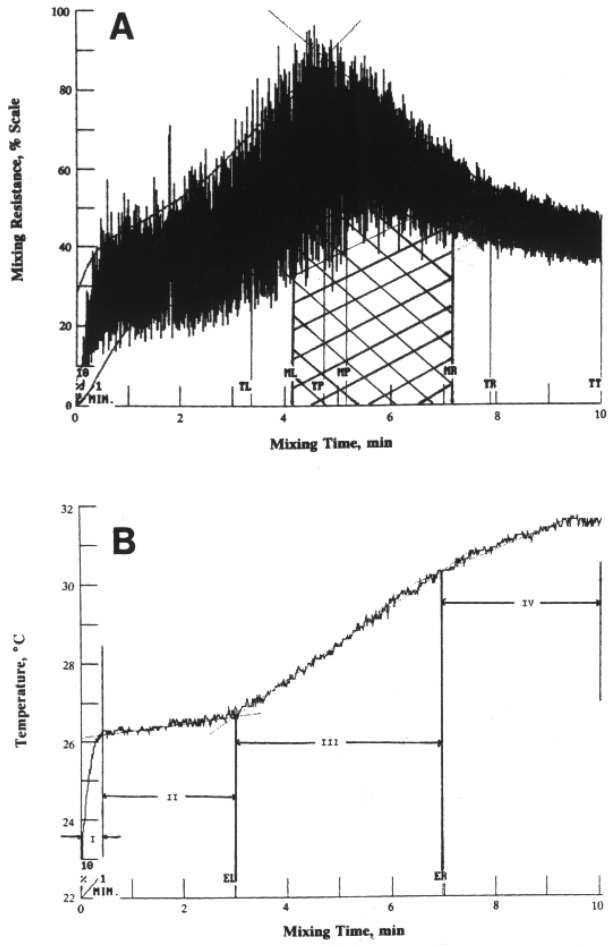



Fig. 6 Typical mixogram (A) and corresponding temperature curve (B) using an aluminum bowl. The mixogram's cross-hatched area correlated with the slope of the mixing temperature curve, region III. TT = total time, T = top line (envelope), M = midline, E = elbow (inflection point), L = left, P = peak, R = right.

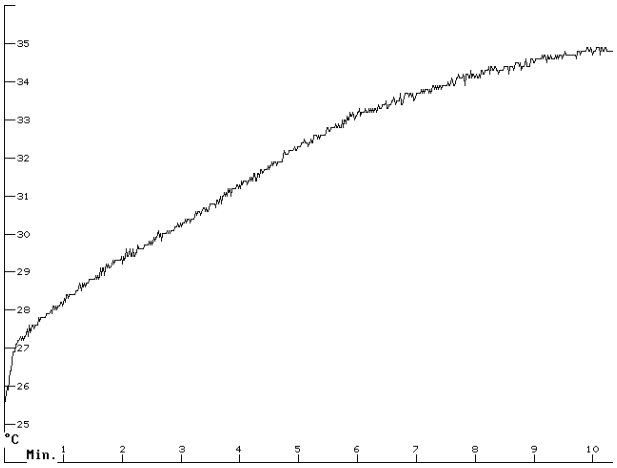



Fig. 7 Typical temperature curve using a Plexiglas bowl. Note that the Plexiglas bowls produced straighter, higher temperature curves, which lacked inflection points.

# Chapter 8
## MIXOGRAPH PIN PATHS AND POINTS OF MINIMUM CLEARANCE

C. E. Walker, and J. L. Hazelton

Dept. of Grain Science and Industry, Kansas State University, Manhattan, KS, USA.

Mixing is a complex process that converts flour and water into a viscoelastic dough. The mere addition of water to flour is not enough to make a dough under most circumstances. Mechanical energy (work input through mixing) must be applied. Mixing to an optimum consistency requires that a certain amount of work be done on the dough. Simplified, work input is equal to the mixing time × the efficiency of the mixing action × the speed at which the energy is put into the dough (Hoseney and Finney 1974). In theory, the more rapidly energy can be imparted into the developing dough, the more rapidly the mixing peak (optimum development) will occur. Therefore, the relative efficiency of mixing with respect to the shear force imparted by the revolving head pins and the resisting bowl pins upon the dough trapped between them can be important.

Swanson and Working's (1933) first recording dough mixers had no bowl pins and accommodated approximately 100g of flour. These initial attempts at mixing small doughs were not entirely successful because the dough rode around on the four moving pins. To facilitate adequate mixing, fixed bowl pins were added. They observed that there existed crescent moon-shaped cavities within the trace of the revolving pins where fixed bowl pins could reside, avoiding the paths of the moving pins. They experimented with two to four bowl pins, finally selecting three (Shogren 1990). Up to this point, the bowl had been assumed to remain in a fixed position. However, the bowl could be permitted to rotate slightly without the pins (head and bowl) clashing (Swanson and Working 1933). This concept eventually led to a slightly rotating, or oscillating bowl (±19°; an arc of about 38 degrees) system which is still used in today's conventional, moving bowl Mixographs.

**PIN PATH**

Several authors have devoted considerable space to calculating pin paths and explaining fixed and moving pin interactions. The reader is referred to them for more details (Steele et al. 1990, Buchholz 1990). The following is intended to be a simplified presentation, illustrating the general picture.

This is the path of any individual Mixograph planetary head pin during four complete head revolutions (Fig 1). The individual moving head gear makes 3 rotations during that same time. During four head revolutions, each pin eventually traces the same path, so only one needs to be calculated.

The planetary gear has 16 teeth, while the fixed gear has 12 teeth, so the planetary gear makes ¾ rotations about its own axis during one head revolution. Therefore, the planetary gear sweeps a net of 1¾ degrees for each degree the planetary head rotates. The equations to plot a pin path are: X = R Sin Theta + r Sin (1.75 Theta), and Y = R Cos Theta + r Cos (1.75 Theta), where X and Y are the Cartesian coordinates. R is the distance from the center of revolution of the head (the center of the fixed gear) to the center of the rotation of the outer rotating gear and r is the radius of the rotating gear (Fig. 2). The 1.75 is the 1¾ total turns that the rotating gear makes while traveling about the fixed gear, 1 turn for the moving head revolution plus ¾ of a turn for the moving gear about its own axis. This permits expressing the moving gear rotation in terms of the head revolution.

Bowl Position

The bowl position can be defined by the alignment of the recording pen (0-100% scale) used in the conventional moving bowl configuration. The 0% and 100% pen positions correspond to the minimum and maximum rotations (about ±19°, respectively) of a normally operating moving bowl Mixograph. The fixed bowl design normally is operated at the 50% pen position, which also coincides with the maximum clearance between the bowl and head pins.

PinShow, a computer program (AEW Consulting, Lincoln, NE), can be used to better understand pin interactions. This graphical representation of the planetary pin path demonstrates the position of the moving head pins in relation to the bowl pins at any given time. The head and bowl pins are colored differently and also one pin is marked so as to differentiate each pin within a pair. The bowl can be 'rotated' to simulate any given pen position and the head rotation speed can be controlled to facilitate observations.

Sample fixed bowl mixograms collected at 10 Hz and representing the 0%, 50%, and 100% pen positions are shown in Figure 3. Changing the orientation of the stationary bowl pins relative to the moving pins of the mixing head by rotating the bowl did result in significant changes in mixogram midline peak time, height, width, integral, right-of-peak slope, and tail width ($P>0.01$).

As the bowl was rotated from the 0% to 100% positions, peak time decreased from approximately 5 min to 3 min. Peak height increased about 5% as bowl position approached the 50% pen position, where it stabilized before decreasing slightly. Peak width remained relatively unchanged, whereas peak integral decreased substantially by about 55 units. Width at peak +3 min decreased approximately 6%.

Rotating the bowl toward the 0% pen position places the bowl pins closer to the path of the advancing planetary pins. The reduced pin clearance apparently caused the dough mass to be pushed or compressed around the bowl pin rather than divided by it. The lack of adequate shear resulted in a longer mix time

and increased total work input (integral) and curve width. Overall, mixograms obtained at the 0% pen position were characterized by wild swings and wide, flat curves that lacked distinct peaks (Fig. 3).

Although the bowl pins at both the 0% and 100% pen position were relatively the same distance from the head pin path, the resulting mixograms were significantly different. With the bowl fixed at the 100% pen position, the bowl pins were placed close to the path of the retreating planetary pins. This pin orientation resulted in narrower curves with sharper peaks, but reproducible results were difficult to achieve. This difficulty was partially caused by a strong tendency for small dough pieces to separate and ride around with, or on top of, the rotating mixing head, producing extremely wild spikes early in the mixing process (Fig. 3). Similar results were reported by Gras et al (1992).

**PIN SIZE AND CLEARANCE**

Fixed bowl pins were originally used to facilitate adequate mixing (Swanson and Working 1933). Within the revolving pin's path, there was sufficient clearance to allow the bowl to move slightly (Fig. 1). When the smaller 10g Mixograph was being developed, the planetary and bowl pin diameters were reduced from 1/8 inch (used with the 35g Mixograph) to 3/32 inch to allow sufficient pin space during operation (Finney and Shogren 1972). Note that the 1/8 inch to 3/32 inch change, a ratio of 4:3 or 1.33, is <u>not</u> the same as 1.52, the cube root of the 35g to 10g ratio as predicted by a simple volumetric downscaling (Table 1). The theoretical linear ratio is the cube root of the weight (proportional to volume) ratio and represents the ratio of the side lengths of two cubes containing the relative volumes stated.

Likewise, when the 2g Mixograph was developed, another pin diameter reduction was necessary. A mathematical model was used first in attempting to down size a mixer to the 2g size (Buchholz 1990), extrapolating from the 35g unit. Simple dimensional downscaling of an existing mixer, especially pin size, caused many problems because pin strength becomes an issue.

When comparing the bowl diameters for the 35g, 10g, and 2g size mixers, we note that their ratios are quite close to the theoretical cube root ratio, as are the pin lengths. However, the pin diameters do not closely follow those ratios, a result of the need to use standard diameter rod stock while still maintaining adequate pin strength. As a result, both the 10g and 2g versions have pin diameters that are larger in proportion to the 35g model than would be predicted from the theoretical ratio. Incidentally, for the 100/200 pin mixer, the pin length and diameter differ substantially when calculated on the 100g basis, but agree rather closely when using a 200g basis. The values from Table 1 were taken from the specifications to which the bowls are manufactured, and verified by measuring a number of bowls in use.

Three specially made 35g bowls were provided by National Mfg., with regular or small (1/8"), medium (3/16"), and large (1/4") sized pins. Therefore, the free space between a bowl pin and a moving head pin pair at the time they straddle the bowl pin were 0.281, 0.250, and 0.219 inches for the small, medium, and large size bowl pins, respectively.

Sample mixograms for the three pin sizes are shown in Figure 4. Midline peak time decreased, whereas height, width, and integral (area under the curve) increased, as pin size increased ($P>0.05$). Because the peak integral is a function of the mixing time and height value, this suggests that larger pins provide more efficient energy use.

Even when the dough is breaking down (past peak), considerable energy is still required to stretch the viscous dough around the pins; hence, dough moving around a larger obstacle (pin) needs a larger work input. Furthermore, the clearance between pins (moving vs. stationary) decreases as bowl pin size increases, which requires more energy to push and pull the dough through the clearances during mixing. As demonstrated, the bowl pin diameter does have a significant effect on most mixogram measurements. Therefore, great care needs to be taken in developing pin-type mixers, recognizing that the results from one size may not extrapolate to another. This may explain why the three commercially available Mixographs give similar but not identical results, and required empirical adjustments to their torque sensing mechanisms.

**PIN NUMBER**

National/TMCO pin mixers, widely used in experimental baking and quality control laboratories, are available in several sizes (200g, 100g, 35g, and 10g). All use the same planetary motion found in the Mixograph. Pin mixer bowls have been made with several pin configurations. When the original Mixograph was developed, several configurations (0 to 4 bowl pins) were considered before the present 3-pin design was adopted (Swanson and Working 1933, Shogren 1990). The Mixograph now always uses 3 bowl pins, but the 200g mixer has only 2 pins. Both 2- and 3-pin bowls have been used with the 10, 35, and 100g mixers.

Typical curves for 0, 1, 2, and 3 pin bowls for the fixed- and moving-bowl are shown in Figure 5. Doughs mixed in bowls which did not contain any pins never reached full development during the 10 min test, although an obvious hydration peak always occurred within the first minute. The dough failed to mix properly because there was nothing to keep it from riding around on the head pins. Likewise, no usable curve could be generated due to the lack of consistent bowl torque (measured by the force transmission between the head and bowl by the dough). The single pin produced more "wild" curves, especially with the moving bowl, and the curves were flatter with less distinct peaks (Fig. 5). However, few differences existed between the 2- and 3-pin bowls. The fixed bowl curves for 2- and 3-pins designs were much wider, especially after the peak (breakdown), than the moving bowl traces. Interestingly, longer mix times were characteristic of the moving bowl Mixograph. This may have been because some of the kinetic energy was absorbed by the dampening system of this design

The increases in curve heights resulted in an increase in the net total work input (integral) at midline peak for the fixed bowl design, whereas little change was observed for the

moving bowl design (Fig. 5). However, the envelope-area integral from the moving bowl design tended to decrease, but showed fewer changes for the fixed bowl design. Mixing variations measured by the peak and envelope-area integral values are an indication of the contrast between the two machines.

Curve band widths generally decreased as the number of bowl pins increased. For the moving bowl model, band width at peak was significantly higher for the 1-pin bowl, and was apparently a function of the "wild swings" induced by the single pin (Fig. 5).

Ascending and descending slopes were increasingly steep as the member of pins increased for both fixed and moving bowl Mixographs. The largest slopes were observed for the 3-pin design, again indicating more rapid work input and dough breakdown.

## CONCLUSIONS

A fundamental difference exists between fixed and moving bowl Mixographs. The moving bowl pins continually change position in relation to the head pins in a non-predictable manner because of the bowl's motion. During mixing, the moving bowl generally operates within the 40% to 70% pen position. The apparent transmitted torque varies for the fixed bowl design, reaching a maximum at 50% - 80% equivalent pen position, depending on the sampling technique used. Fixing the bowl within this range produces curves that correspond with the output produced from the moving bowl design.

Increasing shear during mixing reduced dough development time. The size and number of bowl pins affected the relative mixing efficiency. Shear rate increased as the clearance between the resisting bowl pins and the moving head pins decreased where the bowl pin size increased. Mixing times were reduced and peak heights, band widths, and area integrals (work input) increased. The bowl containing only 1 pin produces low, virtually unusable curves indicative of erratic mixing. Both 2- and 3-pin designs develop dough strength more quickly than the single-pin design, but there were few differences between the 2 and 3 pin results. For the fixed bowl, an increased total work input resulted as pin count increased, but the greatest total work input occurred with the moving bowl machine.

## REFERENCES


American Association of Cereal Chemists. 1991. Approved Methods of the AACC, 8th ed. Method 54-40A, approved April 1961, revised October 1988. The Association: St. Paul, MN.

Buchholz, R. H. 1990. An epitrochoidal mixer. Math. Sci. 15:7-14.

Finney, K. F. 1945. Methods of estimating and effects of variety and protein content level on the baking quality of flour. Cereal Chem. 22(2):149-160.

Finney, K. F. and Shogren, M. D. 1972. A ten-gram Mixograph for determining and predicting functional properties of wheat flours. Baker's Dig. 46(2):32-42, 77.

Gras, P. W., Walker, C. E., and Rath, C. R. 1992. Use of laboratory mixers as models for commercial mixers. Pages 42-46 in: Proc. 42nd Annual RACI Cereal Chem. Conference. Christchurch, New Zealand.

Hoseney, R. C. and Finney, P. L. 1974. Mixing - a contrary view. Baker's Dig. 48(1):22-28.

Shogren, M. D. 1990. A short history of the Mixograph. Cereal Foods World 35(5):480-482.

Steele, J. L., Brabec, D. L., and Walker, D. E. 1990. Mixograph instrumentation for moving bowl and fixed bowl comparisons of wheat flour performance. Pages 224-234 in: Proc. Food Processing Automation Conference, May 6-8., Lexington, KY.

Swanson, C. O. and Working, E. B. 1933. Testing the quality of flour by the recording dough mixer. Cereal Chem. 10(1):1-29.

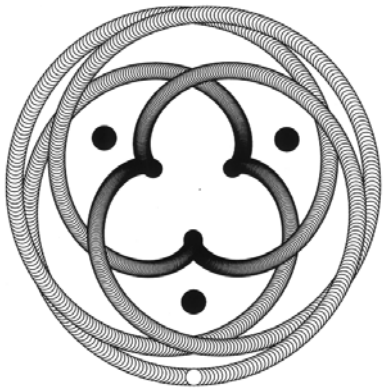



Fig. 1 The actual pin path with fixed bowl pin shown.

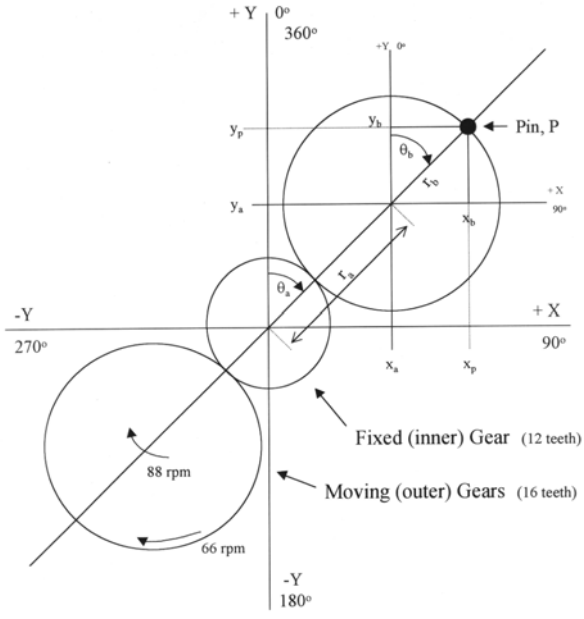



Fig. 2 An illustration of the moving pin path and the calculation from which it is made.

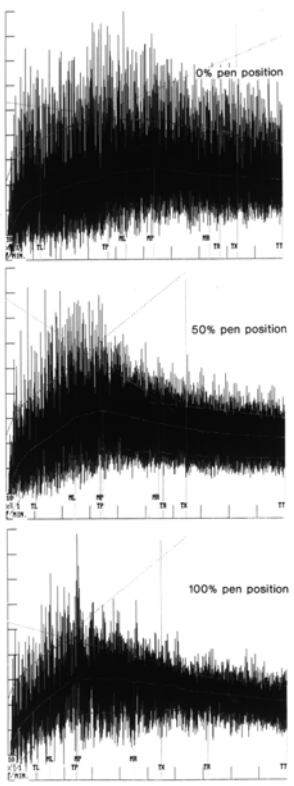



Fig. 3 Sample mixograms collected at 10 Hz with the bowl position fixed at 0%, 50%, and 100% pen positions.

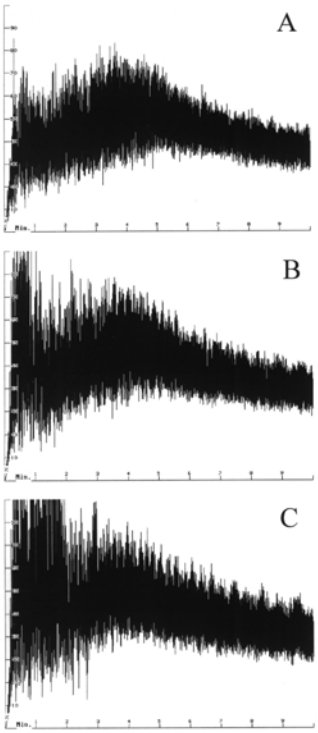



Fig. 4 Sample mixograms using small (A), medium (B), and large (C) size bowl pins.

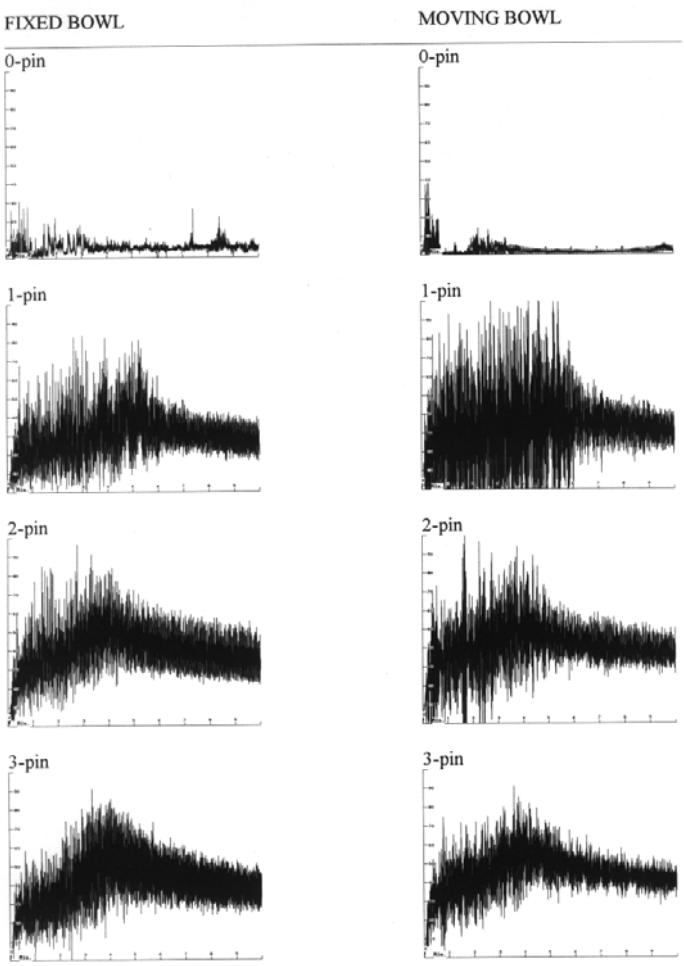



Fig. 5 Sample mixograms for the 0, 1, 2, and 3 pin bowl for both the fix- and moving-bowl machines.

# TABLE 1

## Mixograph Bowl Dimensions Size Comparison

| Bowl Dimensions (inch) | Bowl Size | | | | Ratio | |
|---|---|---|---|---|---|---|
| | Pin Mixer | 35 gram | 10 gram | 2 gram | 35/10 | 35/2 |
| Sample Weight (g) | 100-200 | 35 | 10 | 2 | 3.5:1 | 17.5:1 |
| Theoretical Linear Ratio | --- | --- | --- | --- | 1.518 | 2.596 |
| Bowl Diameter (in) | 4.970 | 2.968 | 1.875 | 1.306 | 1.583 | 2.272 |
| Pin Length (in) | 4.250 | 1.575 | 1.375 | 0.600 | 1.145 | 2.625 |
| Pin Diameter (in) | 0.312 | 0.125 | 0.094 | 0.072 | 1.330 | 1.736 |
| Pin Clearance* (in) | 0.500 | 0.281 | 0.172 | 0.135 | 1.633 | 2.081 |

* the free space between a bowl pin and a moving head pin pair at the time they straddle the bowl pin.

# Chapter 9
# COMPUTERIZING THE MIXOGRAPH: DATA COLLECTION AND ANALYSIS

C. E. Walker[1], A. E. Walker[2], and J. L. Hazelton[1]

[1]Dept. Of Grain Science and Industry, Kansas State University, Manhattan, KS, USA, and [2]AEW Consulting, Lincoln, NE, USA

The inventors of the Mixograph, Drs. Swanson and Working, attempted a number of different approaches to collecting the torque measurements needed to compare different wheat flours which were being studied for bread making properties. During the course of their work, early prototypes used several techniques, including all those methods being used in the current models. Limitations in the sensitivity of the sensors available to them, as well as severe cost restrictions led them to settle upon the mechanical moving-bowl technique, a form of kymograph. This concept was in turn adapted by G. Ferris when National Manufacturing Co. made the equipment commercially available.

Basically there are two common techniques which may be used to measure resistance to mixing. The first technique measures the torque transmitted through the dough to the bowl. This is accomplished by either restraining the bowl to very little motion and measuring the force required to do so (e.g., by a load cell) or by permitting the bowl to move a significant amount against a restraint which increases with degree of rotation (e.g., the present moving-bowl) and measuring the resulting displacement. The second principal method is to measure the mechanical force required to turn the mixing blades or pins. This method uses either a torque dynamometer or measures the electrical power input to the motor driving the mixer. All methods have their advantages and disadvantages.

The moving-bowl method was selected by Swanson and Working for the Mixograph, whereas the torque dynamometer was selected by Brabender for the Farinograph. The bowl was permitted to rotate, limited by stops to ± 19°, restricted by a spring, and dampened (originally) by an inertial spindle mechanism. A pen was attached to the oscillating bowl, and scribed the characteristic mixing curve on a clock-driven strip chart. The time to reach the curve peak was taken as the Mixograph mixing time and its height measured the dough's strength, or resistance to mixing. General curve characteristics were found to be useful flour quality indicators. For example, excessive amounts of sway in the midline of the ascending mixing curve arm indicated excess water, whereas wild swings indicated too little water. Likewise, the curve width and the rate at which it broke down, or fell after the peak, indicated mixing tolerance.

The moving-bowl can be digitized by attaching a position sensor (potentiometer) to the oscillating bearing shaft. The potentiometer senses the position of the mixing arm (or pen) and gives an output voltage proportional to the mixing arm position. The varying voltage from the potentiometer is proportional to the torque imparted to the fixed bowl pins by the mixing action of the head pins. A transducer power supply and signal amplifier with integral 10 bit A/D converter conditioned the analog signal and transmitted it to the parallel port of an MS-DOS computer. The signal, digital values between 0 and 1023, was acquired and analyzed by computer software. The resulting electrical signal can be graphed, producing a curve almost exactly like the mechanical pen trace, but which could also be analyzed by a computer (Fig. 1).

The fixed-bowl design was developed to use the existing machine (no change to the bowl or mixing action) by restraining the swinging bowl mechanism to a very small movement by a load cell. The analog voltage output of the load cell is proportional to the mixing torque imparted onto the fixed bowl pins (Fig. 1). Like the digitized moving-bowl configuration, the varying voltage is converted to a relative numeric scale by an A/D circuit and the signal is acquired and analyzed by the computer software. This configuration reduces possible variances caused by bearings, springs, and dampening mechanisms. However, it made the mixing curve (mixogram) more sensitive to small, higher frequency changes in the mixing torque by eliminated the spring and damper concerns. The electrical signal from the load cell could easily be acquired by a data analysis system. Because the bowl was relatively fixed in position, it was also possible to control the relative positions of the head and bowl pins at the time that the transmitted torque was sampled. Some experienced users, accustomed to the original curve's characteristic shapes, were not comfortable with the fixed-bowl design, but it was ideal for mixing research.

Fixed-bowl torque sampling methods affect the resulting mixing curve. The torque values may be sampled at various frequencies when the sampling procedure is not synchronized with the mixing head position. The sampling may occur when the bowl is in different positions (as occurs with a moving-bowl design), or sampling may be synchronized with the head rotations so that the head and bowl pins are always in the same relative position. This is relevant because, during the planetary heads rotation, head pins may be pushing the dough against a bowl pin, pulling it away, straddling or hurdling the bowl pins. The clearance between head and bowl pins can vary from near touching to several centimeters through out the 1440 degrees rotation required to bring the head pins back to their starting position. Sampling at fixed as opposed to random head positions (synchronization) will be discussed in the next chapter.

Yet, another method, which measures the direct power input, was used for the 2-gram, direct-drive Mixograph. This design was developed to meet the increasingly urgent need expressed by plant breeders and protein scientists for small sample sizes. It used a DC motor with integral tachometer. As resistance to mixing increased, increasing power was drawn by the motor

to maintain the constant speed. That electrical power demand was measured, and when graphed, producing a mixing curve that very closely resembles the curves produced by the larger moving and fixed-bowl 10- and 35-gram Mixographs. Again, the data could be analyzed automatically.

All the above methods could generate analog electrical signals, which could be acquired and digitized by a relatively inexpensive A/D interface card mounted in a personal computer. These digitized values could then be plotted on a computer screen or sent to the printer. This alone would have provided little advantage over Swanson and Working's simple kymograph, but once the data was in digital form, it was relatively easy to analyze, quickly, reproducibly, and objectively by providing numerical values for curve times, heights, band widths, areas (representing work input) etc. (Table 1).

For those who had saved mixograms from many years past, it was also possible to scan the old curves and synthesize a data set comparable to those collected by modern computerized instruments. The same software was used, so many year's data could easily be compiled in spreadsheet form for statistical analysis.

**SAMPLING FREQUENCY EFFECTS**

Some researchers (Stearns and Barta 1990; Navickis et al. 1990) have stressed the necessity of sampling at high frequencies (at least 50 Hz), whereas some (Voisey et al 1966) found that a moderate frequency of 4 Hz was satisfactory. However, very low sampling frequencies (1 to 2 Hz) were found to cause problems during data collection and analysis (Rubenthaler and King 1986).

A useful technique for studying the relative merits of sampling at different frequencies is to initially collect data at a high frequency and then systematically strip, or remove part of, the data (Walker and Walker 1992). By controlling the stripping pattern, the effects of sampling frequency on the identical data set can be shown in a manner that is exactly the same as originally collecting data at different frequencies, but without the small random error and variability that occurs between two replicate samples.

*Mixograph Description*

A 10g Mixograph provided by the National Mfg. Div. of TMCO (Lincoln, NE) was used. The Mixograph was operated in two interchangeable configurations, moving-bowl and fixed-bowl. The moving-bowl design was computerized for digitized acquisition by placing a linear taper rotary contact potentiometer in the original bowl bearing housing (Wooding and Walker 1992). The potentiometer provided an analog voltage signal to the computer, which was proportional to the bowl's position, and hence collected data identical to the mechanical pen trace (digitized moving-bowl). For the fixed-bowl configuration, a bracket and load cell were attached to the bearing housing to immobilize the moving bowl arm at the 50% pen position. The analog voltage output of the load cell is proportional to the torque imparted to the fixed bowl pins by the action of the planetary mixing head on the dough. A transducer power supply and signal amplifier with integral 10 bit A/D converter conditioned the analog signal from either Mixograph configuration and transmitted it to the parallel port of an MS-DOS computer. The signal was acquired and analyzed by MixSmart software, written by AEW Consulting (Lincoln, NE) and now commercially available through National Mfg. (Walker and Walker 1990). Data were collected at 50 Hz.

*Software Description*

The mixogram data file-stripping feature, a special modification to the MixSmart program, was developed by AEW Consulting (Lincoln, NE). To preserve the original file, the utility is capable of generating new files that contain the new header file information (time, frequency, etc.). This utility works by selecting every $n^{th}$ data point for retention and eliminating those points in between. For example, setting the stripping factor at 2 (every second point is retained) strips a file collected at 50 Hz to an effective sampling rate of 25 Hz. The stripping factor need not be an integer. For instance, setting the stripping factor at 2.5 will alternately retain the second and then the third data pints, eliminating first one then two intermediate values.

*Flour Description and Methodology*

A high protein, spring wheat flour (at 14% mb: 64.3% absorption, 14.2% protein, and 0.51% ash), supplied by the Bay State Milling Co. (Quincy, MA), was used. Approximate Mixograph absorption was predicted first according to Finney (1945) and subsequently adjusted, based on preliminary runs with the fixed-bowl configuration. Flour-water mixograms were run at 25±1°C following the standard Mixograph method, AACC 54-40A, modified only to accommodate the computerized format (AACC 1991). Mixer speed was 88.2 rpm, and mixograms were run for 10 min.

*Experimental Design*

A series of mixograms were collected at 50 Hz. The data files then were stripped systematically to 25, 10, 5, 2, and 1 Hz. One-way ANOVA was performed on selected mixing parameters to identify any significant differences among sampling frequencies.

*Result and Discussion*

No significant differences occurred in the values derived from the original mixograms, no matter what frequencies were considered ($P>0.01$). The similarity across frequencies applied even as low as 1 Hz, though below 5 Hz, small differences can be seen, especially in the band widths at different locations (Table 2 and Fig. 2). Although only one flour was used, similar results would hold true for any other flour of differing protein and mixing characteristics. These results support earlier findings (Walker and Walker 1992). For those studies in which sampling frequency was shown to be important, differences may be attributed to the nature of the software employed to calculate the various parameters (Voisey et al. 1966; Rubenthaler and King 1986; Navickis et al. 1990; Streans and Barta 1990).

Fixed-bowl mixograms are characteristically wide because the load cell is more responsive to rapid fluctuations than the heavily dampened moving-bowl design. This was documented when band widths steadily decreased as sampling

frequency was reduced (Table 2). As the sampling frequency decreased, less probability existed of capturing the extremes, so band width began to decrease (Fig. 2). Although relatively little change occurred through about 10 Hz, the reduced band width became apparent at about 5 Hz, and much more so at 2 and 1 Hz. The change in band width as a function of sampling frequency was more dramatic for the fixed- than moving-bowl configuration (Table 2).

Starting at about 2 Hz, a cyclical or harmonic pattern can be seen (Fig. 2). This pattern was the result of the interaction of two or more frequencies beating against each other, producing a frequency equal to the difference between them. This phenomenon was probably caused by the very complex mixing action. Furthermore, restrictions of the computer monitor resolution resulted in a pattern that appears to repeat, almost like a sine wave. The apparent variation in mixing resistance is purely an artifact of the collection and display process. Nevertheless, the software analysis uses only the actual data points to produce the mid and envelope lines, even at very low sampling frequencies.

*Conclusions*

Differences among mixogram parameters from the same file but analyzed at different apparent frequencies are similar to or less than the differences between replicate samples. Except for band width, essentially the same results were found for the different sampling frequencies. This justifies the use of lower sampling frequencies, i.e., 10 Hz, rather than the much higher frequencies sometimes used by engineers to collect data.

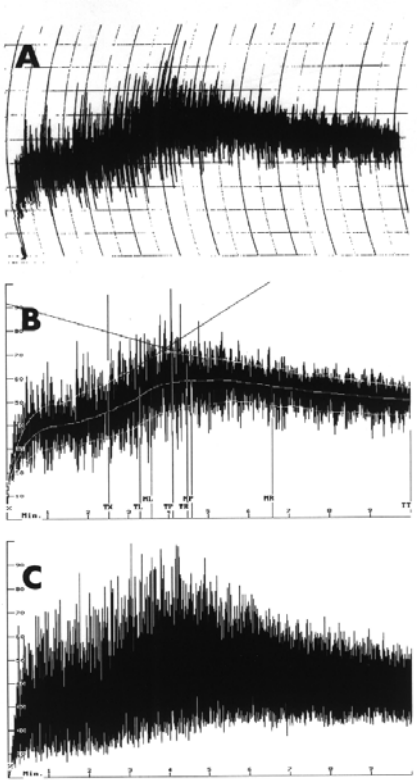



Fig. 1 Sample moving-bowl (A and B) and fixed-bowl (C) mixograms. The moving-bowl mixograms were simultaneously collected by two methods (A) mechanical pen trace and (B) digitized position transducer signal.

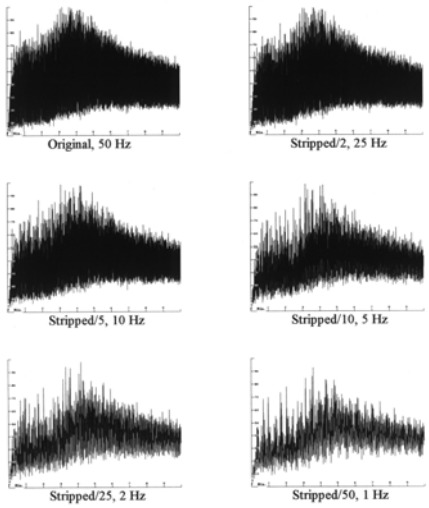



Fig. 2 Fixed-bowl mixograms created from a file collected at 50 Hz and subsequently stripped to emulate lower sampling frequencies.

**REFERENCES**

American Association of Cereal Chemists. 1991. Approved Methods of the AACC, 8th ed. Method 54-40A, approved April 1961, revised Oct. 1988. The Association: St. Paul, MN.

Finney, K. F. 1945. Methods of estimating and effects of variety and protein content level on the baking quality of flour. Cereal Chem. 22(2):149-160.

Navickis, L. L., Rubenthaler, G. S., Nelson, T. C., and Butterfield, R. O. 1990. Evaluating mixogram parameters by electronic torque sensing. Cereal Foods World 35(5):493-496.

Rubenthaler, G. S. and King, G. E. 1986. Computer characterization of mixograms and their relationship to baking performance Pages 131-168 in: Fundamentals of Dough Rheology. H. Faridi and J. M. Faubion, eds. Am. Assoc. Cereal Chem.: St. Paul, MN.

Stearns, M. and Barta, S. 1990. Mixograph standardization/digital data acquisition. Cereal Foods World 35(5):485-488.

Walker, A. E. and Walker, C. E. 1992. Documentation and User Instructions for MixSmart© Software. National Mfg. Div. TMCO.: Lincoln, NE.

Wooding, A. R. and Walker, C. E. 1992. Comparison of alternative recording mechanisms (mobile vs. fixed-bowl) for the 35- and 10-gram Mixographs. Cereal Chem. 69(3):249-253.

Voisey, P. W., Miller, H., and Kloek, M. 1966. An electronic recording mixer. Part I: The apparatus. Cereal Chem. 43(4):408-419.

TABLE 1
Sample Mixogram Report

120A01.MXG

120A01.MXG 03-27-1992 13:13:15 Analyzed: 04-29-1994 14:00:55

| VARIABLE NAME | VALUE | VARIABLE NAME | VALUE |
|---|---|---|---|
| Total Run Time (Min.) | 10.00 | Frequency (Samples/Sec) | 4.396 |
| Mid Curve Filter | 160 | Mid Curve No. Stages | 1 |
| Delta Left of Peak (Min.) | 1.00 | Delta Right of Peak (Min.) | 2.00 |
| Tq. Min. Std. Reading | 18 | Tq. Max. Std. Reading | 361 |
| Analysis Start Time (Min.) | 0.00 | Delta End Time (Min.) | 0.00 |
| Top Finder Window (Sec.) | 0.7 | Bottom Finder Window (Sec.) | 0.7 |
| Top Curve Filter | 160 | Top Curve No. Stages | 1 |
| Bottom Curve Filter | 160 | Bottom Curve No. Stages | 1 |
| Arbitrary Time 'X' (Min.) | MP*.55 | Tq. Slope Scanning Window | 7.5 |
| Use Manual First Mid Peak | Yes | Mid Peak Fit Window (%) | 0.0 |
| Use Manual First Top Peak | No | Top Peak Fit Window (%) | 5.0 |

| Title (Min.) | Time (%) | Value (%/Min.) | Slope (%) | Width (%Tq*Min.) | Integral |
|---|---|---|---|---|---|
| ENVELOPE ANALYSIS: | | | | | |
| LEFT_OF_PEAK | 1.25 | 49.6 | 8.34 | 30.3 | |
| PEAK | 3.56 | 62.3 | =0= | 30.9 | |
| RIGHT_OF_PEAK | 6.99 | 40.9 | -8.09 | 6.8 | |
| CURVE_TAIL | 10.00 | 34.8 | -1.03 | 3.9 | |
| TIME_'X' | 2.20 | 55.2 | 2.61 | 32.1 | |
| MID LINE ANALYSIS: | | | | | |
| LEFT_OF_PEAK | 3.01 | 42.4 | 8.18 | 32.1 | 94.0 |
| PEAK | 4.01 | 46.9 | =0= | 27.1 | 139.3 |
| RIGHT_OF_PEAK | 6.01 | 40.8 | -5.53 | 11.1 | 228.0 |
| CURVE_TAIL | 10.00 | 33.0 | -0.83 | 3.9 | 371.2 |
| TIME_'X' | 2.20 | 36.3 | 5.56 | 32.1 | 62.6 |
| ENVELOPE AREA ANALYSIS: | | | | | |
| TIME_RANGE | 4.01 To | 6.01 | | | |
| MID_LINE_SLOPE | | | -3.02 | | |
| ENVELOPE_AREA | | | | | 37.1 |

# TABLE 2

## Averaged Mixogram Values for High Frequency Mixograms and Mixograms Created by Electronic Stripping Methods

| | Midline Peak | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Time | | Height | | Width | | Integral | |
| | avg | sd | avg | sd | avg | sd | avg | sd |
| Moving Bowl | | | | | | | | |
| 50 Hz | 4.62 | 0.07 | 59.30 | 0.72 | 23.07 | 2.06 | 208.07 | 6.81 |
| 25 Hz | 4.62 | 0.07 | 59.30 | 0.72 | 22.97 | 2.07 | 208.10 | 6.85 |
| 10 Hz | 4.64 | 0.05 | 59.33 | 0.71 | 20.63 | 1.60 | 208.87 | 5.42 |
| 5 Hz | 4.65 | 0.04 | 59.33 | 0.71 | 20.83 | 1.45 | 209.33 | 5.05 |
| 2 Hz | 4.69 | 0.00 | 59.37 | 0.91 | 14.10 | 0.79 | 212.20 | 2.82 |
| 1 Hz | 4.55 | 0.55 | 60.53 | 1.10 | --- | --- | 204.67 | 33.42 |
| avg | 4.63 | 0.13 | 59.53 | 0.81 | 20.32 | 1.60 | 208.54 | 10.06 |
| c. v. % | | 2.81 | | 1.36 | | 7.85 | | 4.82 |
| Fixed Bowl | | | | | | | | |
| 50 Hz | 4.67 | 0.10 | 47.33 | 1.03 | 57.77 | 0.74 | 160.83 | 9.90 |
| 25 Hz | 4.64 | 0.16 | 47.23 | 1.00 | 54.57 | 0.29 | 159.40 | 12.46 |
| 10 Hz | 4.75 | 0.11 | 47.23 | 1.19 | 44.33 | 0.93 | 164.17 | 10.04 |
| 5 Hz | 4.64 | 0.08 | 47.43 | 1.33 | 40.47 | 1.37 | 159.63 | 2.67 |
| 2 Hz | 4.55 | 0.16 | 47.53 | 1.42 | 20.67 | 0.40 | 154.97 | 11.51 |
| 1 Hz | 4.62 | 0.23 | 48.57 | 2.06 | --- | --- | 159.17 | 4.24 |
| avg | 4.65 | 0.14 | 47.56 | 1.34 | 43.56 | 0.74 | 159.69 | 8.47 |
| c. v. % | | 2.99 | | 2.81 | | 1.71 | | 5.30 |

c.v.% = coefficient of variance

# CHAPTER 10
# CHANGING MIXOGRAM APPEARANCE BY SAMPLING AT SYNCHRONIZED HEAD PIN POSITIONS

J. L. Hazelton[1], C. E. Walker[1], and A. E. Walker[2]

[1]Dept. Grain Science and Industry, Kansas State University, Manhattan, KS, USA and [2]A. E. Consulting, Lincoln, NE, USA.
Reprinted with permission from Cereal Foods World 41(7):631-634.

## INTRODUCTION

The fixed-bowl Mixograph has numerous advantages in mechanics, electronics, cost, size, weight, space, and time to analyze when compared to the conventional moving-bowl design. As it is more sensitive to smaller fluctuations than the heavily dampened mechanisms of its predecessor, the increased sensitivity results in a substantially wider mixogram band. While significant correlations between designs (moving-bowl, fixed-bowl, and direct-drive) have been demonstrated (Wooding and Walker 1992), variation in analysis do occur, especially when subjective interpretation is involved. To those experienced operators who have long been accustomed to the narrower, heavily dampened, moving-bowl traces, fixed-bowl mixograms appear to be different.

The relative bowl and head pin positions at the time torque is sampled affect the resulting mixogram. The objectives were to identify characteristic torque patterns while measuring transmitted torque at different mixing head positions and to select a sampling protocol to produce fixed-bowl mixograms that more closely resemble moving-bowl traces, while being sensitive to differences among flours.

## MATERIALS AND METHODS

*Mixograph Description*

A 10g Mixograph (National Mfg. Div. of TMCO, Lincoln, NE) was operated in two interchangeable configurations, moving-bowl and fixed-bowl. The moving-bowl design was computerized for digitized acquisition by placing a linear taper rotary contact potentiometer in the original bowl bearing housing (Wooding and Walker 1992). The potentiometer provided an analog voltage signal to the computer, which was proportional to the bowl's position. Consequently, the mixogram was nearly identical to the mechanical pen trace.

For the fixed-bowl configuration, a bracket was attached to the bearing housing so that the moving-bowl arm could be immobilized by a load cell at the 50% pen position. The analog voltage output of the load cell is proportional to the torque imparted to the fixed bowl pins by the action of the planetary mixing head on the dough. A transducer power supply and signal amplifier with integral 10-bit A/D converter conditioned the analog signal from either Mixograph configuration and transmitted it to the parallel port of a computer.

*Data Acquisition Hardware and Software*

Torque measurements can be made randomly anywhere along the pin path at a fixed sampling frequency (typically 10 Hz, but satisfactory curves have been obtained from 1 Hz to 50 Hz). Alternatively, data collection can be synchronized to the angular position of the mixing head in order to sample torque when the head pins are at specific locations. To better visualize the pin orientations, the PinShow computer program (AEW Consulting) was used. This graphic representation of the planetary pin path demonstrated the position of the moving head pins in relation to the stationary bowl pins.

The Mixograph was fitted with a special shaft-position-sensing device mounted on top of the main mixing head shaft (Fig. 1). The device was programmed to function at particular step-sizes and off-set values. Step-size (degrees of head rotation) was a notation that defined the position of the mixing head during sampling, determining the sampling rate (frequency) as the head made one revolution. Four complete revolutions (1440°) are necessary to return all head pins back to their initial starting positions. The specific position at which the sampling started was referred to as the "off-set". The "home" or head pin template shipping position is considered to be 0° off-set. Synchronization was designated in a step-size/off-set format where 60°/15° designated sampling every 60° starting at 15° rotation from home position.

An integrated version of the MixSmart software package (National Mfg. and AEW Consulting, Lincoln, NE) was used to collect and analysis the data. Approximately 40 different mixing parameters were derived by the software. Peak time (min.), peak height (% scale), and envelope band width (% of full scale) were derived from the midline. The integral (work input) was defined by the area under the curve. The left-of-peak (LOP, by 1 min) parameters (height, slope, and band width) also were assessed as an indication of proper absorption. The right-of-peak (ROP, by 2 min) height and slope and envelope area (curve area between the upper and lower envelope lines from peak to ROP) were used to estimate four strength.

*Flour Descriptions and Methodology*

Four flours with various mixing characteristics were used. A commercially available, high-gluten flour (63.0%absorption, 13.0%protein), donated by General Mills, Minneapolis, MN and three HRW flours milled form the Wheat Quality Council's yield trials, which included 705 (Larned: 62.0% absorption, 12.3% protein); 802 (04884837: 60.2% absorption, 11.2% protein); and 810 (Longhorn: 61.4% absorption, 11.9% protein). All calculations were based on 14% mb.

Flour-water mixograms were run at 25±1° C following the standard Mixograph method, AACC 54-40A, modified only to accommodate the computerized format (AACC 1991). Mixograms were run for 10 min, with a mixing head speed of 88.0 rpm. Starting Mixograph absorption was first calculated based on protein and subsequently adjusted, based upon preliminary runs with the fixed-bowl design. The high-gluten flour was used for the preliminary work. Then for confirmation, the other three flours were analyzed with a more restricted set of sampling frequencies and off-set values.

*Experimental Design*

Prior to collecting the main set of data, preliminary runs were made with both the moving- and fixed-bowl designs and sampling techniques. Data were collected at a relatively high frequency. Randomized sampling was conducted at 88 Hz, and synchronized sampling at 6°/0° or approximately 88.2 Hz for 0.12 min to identify the head pin positions that appeared to be most and least sensitive to changing torque and, thus, affected the curve band widths. To observe the effects of various head positions during sampling, several series were run using the fixed-bowl configuration (Table 1). Sampling was conducted at regular increments of the main shaft's rotation (step-size). The home position was the starting point (0°) and subsequent increments were evaluated (off-set).

Based on the above results, verification of the synchronized sampling models was tested with three additional flours. Both Mixograph configurations (digitized moving-bowl and fixed-bowl) were used. First, they were run at 10 Hz, ignoring head position (random), and then at selected, synchronized values for angular displacement and off-set (60/20, 60/50, 120/0, 120/60, 240/0, and 240/160).

Selected parameters from the analysis reports were exported directly into a spreadsheet for subsequent analysis. One-way analyses of variance (ANOVA) on each parameter were run to determine if any significant differences occurred among the sampling protocols and whether the flours could still be differentiated.

## RESULTS AND DISCUSSION

*Sampling Protocol Development*

When the relatively high-speed data collection was used for a short time period, "stretching out" the torque curve, its pattern could be seen. At this frequency (approximately 88 Hz for 0.12 min), the number of data points was approximately the same as the horizontal resolution on the VGA computer monitor, one point per column.

The high speed sampling technique was attempted first on the moving-bowl design. As predicted, the moving-bowl showed no repeating torque pattern from either the random or the synchronized sampling methods (data not shown). Because the bowl was allowed to rotate, the distance between bowl and head pins was not consistent at any location along the pin path.

However, a repeating torque pattern was found for the fixed-bowl configuration (Fig. 2). A total of 1440° or four total revolutions of the head was required to bring all head pins back to their original starting points, during which time six minima and six maxima occurred every 240° of head rotation. The minima started at 30° off-set from the home position, whereas the maxima started at 180° off-set. Steele et al. (1990) predicted a similar repeating pattern (six sub-cycles) in their simulation study. They developed equations defining the path of each moving pin in terms of input shaft rotation, including the torque cycles for pins moving in a uniform viscous liquid. Figure 3 illustrates the pin orientations for the minimum and maximum torques created at 30° and 180° off-set, respectively. As the mixing head shaft advanced 240° clockwise from the respective off-sets, the head pin placement appeared to progress counter-clockwise to the same relative position about the next bowl pin.

One-way ANOVA for sampling position showed no significant effects on any of the mixogram parameters except band width. We observed that sampling at every 60°/0° (step-size/off-set) resulted in an extremely wide band. This was due to collecting all of the highest torque measurements. Steele and co-workers (1990) also found that the first average total torque would occur at 60°. However, as the off-set approached 30°, somewhat lower torque signals were then collected, resulting in a slightly narrower band width. The sampling location was again shifted back to the torque maximums as off-set returned to the starting position. For each step-size, 80°, 120°, and 240°, changes in band widths were found when sampling locations were altered as off-set was changed (Fig. 4).

We noticed that when data points were taken every 120° rotation, starting at 0° off-set, the torque extremes were avoided and band widths were reduced, particularly in the tail region (Fig. 4). The sampling frequency for 120°/0° is approximately 4.4 Hz, the same frequency that Steel and co-workers (1990) calculated that would be necessary to identify a torque cycle for 88 rpm of the main shaft. The resulting curves very closely resembled those from the conventional moving-bowl Mixograph. Figure 5 illustrates the pin orientation for this synchronization protocol. Interestingly, only at every 120° of head rotation, starting at 0° off-set, were the head pin pairs arranged in symmetrical patterns. This sampling protocol functioned by selectively dampening the curve much as the spring, weight, and/or dash pot dampeners of the moving-bowl design.

*Protocol Verification*

Figure 6 shows the effects of synchronized vs. random sampling using three different Mixograph configurations with three flours. Each configuration and sampling protocol test was able to distinguish differences between the flours. However, excessive band widths were best avoided with the 120°/0° synchronized model.

Subsequent to the 10g tests, a 35g unit was fitted with a greatly simplified version of the synchronizing switch (Fig. 7). Without the need to modify the main shaft, it samples torque at specified positions every 120° of the rotating head shaft, starting from the home position or 0° off-set. The frequency for synchronizing 120°/0° is approximately 4.4 Hz, or about one-half the 10 Hz commonly used in randomized data collection with the fixed-bowl. This modification and protocol is now being used routinely in this laboratory on both the 10g and 35g machines.

## CONCLUSIONS

Synchronizing data collection with the relative positions of the head pins and the bowl pins was effective only when used with the fixed-bowl configuration. By sampling every 120° rotation, starting at 0° off-set or "home" position, the curve extremes were avoided. The apparent band width was reduced by initiating the equivalent of mechanical dampening through a selective sampling technique. This method resulted in curves that very closely resembled those from the conventional moving-bowl Mixograph, without losing the sensitivity to detect differences in the flours.

## REFERENCES


American Association of Cereal Chemists. 1991. Approved Methods of the AACC, 8th ed. Method 54-40A, approved April 1961, revised October 1988. The Association: St. Paul, MN.

Buckley, D. J., Lukow, O. M., Lalonde, J. L. M., and Woods, S. M. 1990. A multilevel computer system for dough quality analysis and report distribution. Cereal Foods World. 35(5):472-478.

Finney, K. F. 1945. Methods of estimating and effects of variety and protein content level on the baking quality of flour. Cereal Chem. 22(2):149-160.

Gras, P. W., Hibberd, G. E., and Walker, C. E. 1990. Electronic sensing and interpretation of dough properties using a 35-g Mixograph. Cereal Foods World 35(6):568-571

Hazelton, J. L. and Walker, C. E. 1996. Changing mixogram appearance by sampling at fixed as opposed to random head position. Cereal Foods World. 41(7):631-634.

Navickis, L. L., Butterfield, R. O., and Nelsen, T. C. 1989. A modified electronic torsion sensor for a 10-gram Mixograph. Cereal Chem. 66(4):350-352.

Navickis, L. L., Rubenthaler, G. L., Nelsen, T. C., and Butterfield, R. O. 1990. Evaluating Mixograph parameters by electronic torque sensing. Cereal Foods World. 35(5):493-496.

Rubenthaler, G. L. and King, G. E. 1986. Computer characterization of mixogram and their relationship to baking performance. Pages 131-167 in: Fundamentals of Dough Rheology. H. Faridi and J. M. Faubion, eds. Am Assoc. Cereal Chem.: St. Paul, MN

Stearns, M. M. and Barta, S. 1990. Mixograph standardization/digital data acquisition. Cereal Foods World. 35(5):485-488.

Steele, J. L., Brabec, D. L., and Walker, D. E. 1990. Mixograph instrumentation for moving and fixed bowl comparisons of wheat flour performance. Pages 224-234 in: Proc. Food Processing Automation Conference. May 6-8. Lexington, KY.

Voisey, P. W. and Miller, H. 1970. The Ottawa electronic recording dough mixer. VII. Factors affecting performance and the use of digital recording techniques. Cereal Chem. 44:359-372.

Voisey, P. W., Miller, H., and Kloek, M. 1966. An electronic recording dough mixer. I. The apparatus. Cereal Chem. 43(4):408-419.

Voisey, P. W., Miller, H., and Kloek, M. 1966. An electronic recording dough mixer. II. An experimental evaluation. Cereal Chem. 43(4):420-432.

Voisey, P. W., Miller, H., and Kloek, M. 1966. An electronic recording dough mixer. III. Additional methods of recording. Cereal Chem. 43(4):433-437.

Wooding, A. R. and Walker, C. E. 1992. Comparison of alternative recording mechanisms (mobile vs. fixed-bowl) for the 35- and 10-gram Mixographs. Cereal Chem. 69(3):249-253.


# TABLE 1

## EXPERIMENTAL DESIGN
## Syncronization of Mixing Head Position for Data Collection

| Off-Set | Step-Size (degrees) | | | |
|---|---|---|---|---|
| (degrees) | 60 | 80 | 120 | 240 |
| 0 | X | X | X | X |
| 5 | X | | | |
| 10 | X | X | | |
| 15 | X | | X | |
| 20 | X | X | X | |
| 25 | X | | | |
| 30 | X | X | X | X |
| 35 | X | | | |
| 40 | X | X | | X |
| 45 | X | | X | |
| 50 | X | X | | |
| 55 | X | | | |
| 60 | | X | X | X |
| 70 | | X | | |
| 75 | | | X | |
| 80 | | | | X |
| 90 | | | X | X |
| 105 | | | X | |
| 120 | | | | X |
| 150 | | | | X |
| 160 | | | | X |
| 180 | | | | X |
| 210 | | | | X |

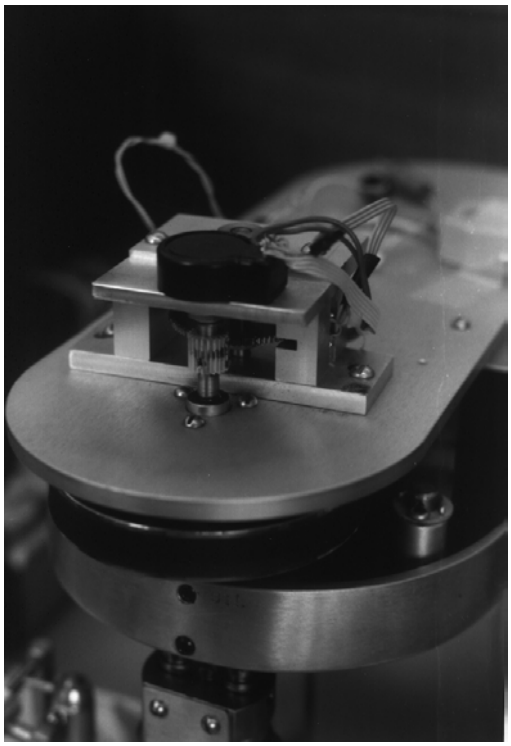


Fig. 1 The shaft position sensing device mounted on top of the main mixing head shaft of a 10g Mixograph.

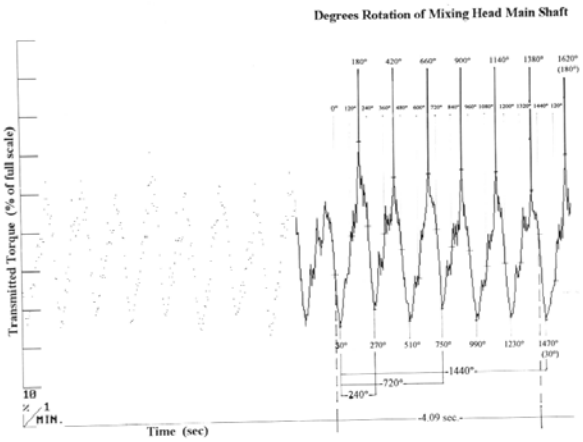



Fig. 2 A high speed, synchronized, fixed-bowl mixogram showing repeating minimum and maximum torques. The left half shows actual data points collected, the right half shows the points connected to more closely resemble the more familiar pen trace.

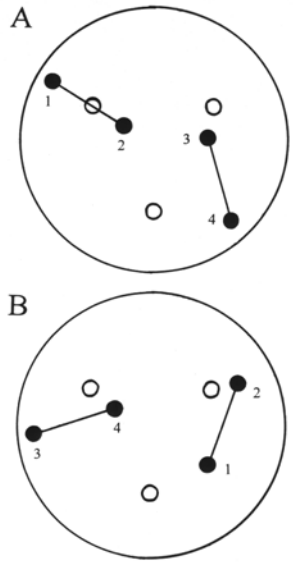



Fig. 3 Head pin orientation during A) minimum and B) maximum torque (at 30° and 180° head rotation, respectively). Note that the pairs of head pins revolve around the bowl at 88 rpm while each pair rotates about its common center at 66 rpm, so a total of 1440° (4 revolutions) are required to return them to the same position.

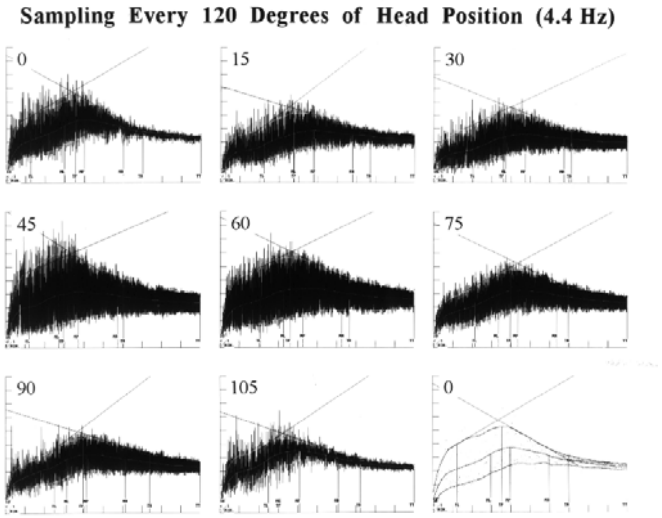



Fig. 4 Mixograms showing synchronized sampling occurring every 120° head rotation, off-set in 15° increments. When 120° off-set is reached, the cycle is repeated.

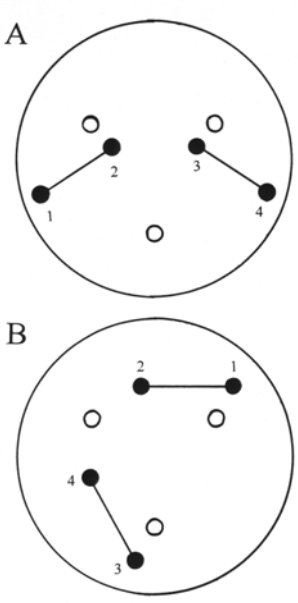



Fig. 5 Head pin orientation for the 120°/0° synchronization model showing A) 0° off-set, or home position, and B) 120° off-set. This pattern then repeats about successive bowl pins.

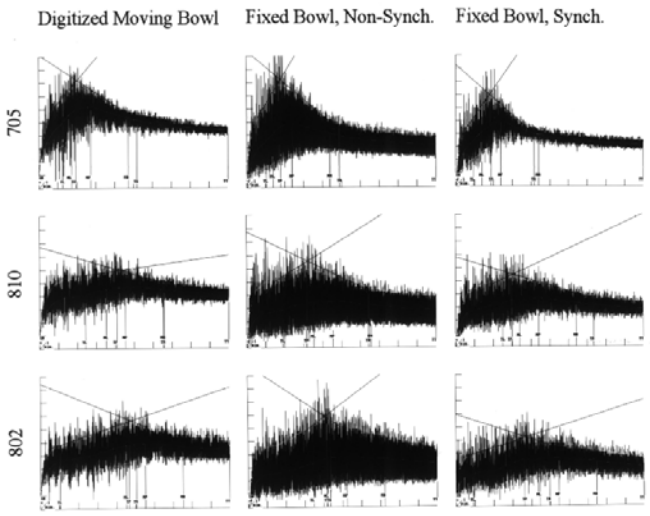



Fig. 6 Verification of the 120/0 synchronization sampling model using three flours. Note that the synchronized-fixed-bowl curves very closely resembled those from the conventional moving-bowl Mixograph.

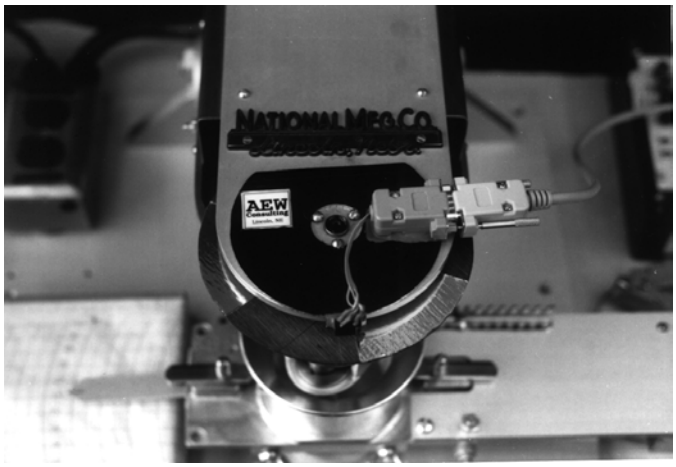



Fig. 7 A simplified version of the shaft position sensing device. It is mounted above the pulley that is attached to the mixing head shaft.

# Chapter 11
# COMPARING CALIBRATIONS

C. E. Walker and J. L. Hazelton

Dept. of Grain Science and Industry, Kansas State University, Manhattan, KS, USA

At the time they published their original paper on the predecessor to the Mixograph, Swanson and Working (1933) made numerous attempts to measure the resistance of a dough to mixing by several different recording methods. However, the absence of an effective dampening system created problems. A watt meter was added to measure the energy needed to mix a dough, but this idea failed due to excessive background noise. Another unsuccessful idea employed a torsion rod concept before they arrived at the present 'restricted moving-bowl' concept.

The original version of this design required a 400g. sample, but which was deemed unsuitable for use by wheat breeders. In 1939, Working designed a smaller version. This unit maintained the essentials of the original machine, but required only 35g of flour (Shogren 1990). The dampening mechanism on the 35g design was changed to include a string and spool system with a coiled spring which restrained the movements of the bowl platform to an arc, approximately ±19° from the mid-point. More recently, the spindle dampening mechanism has been replaced by the addition of a weight to the swing arm (Shogren 1990).

A further down-sizing of the Mixograph to a 10g size was intended to aid in predicting physical and baking properties of early generation plant breeders' wheats, and for fractionation and reconstitution studies. Finney and Shogren (1972) detailed the development and standardization of the 10g Mixograph. At that time, they also defined operating conditions and procedures for recording mixograms and this publication is usually followed for operating and interpreting the results. Finney later developed a prototype 5g machine (Finney 1989). Although statistically significant correlations between the machines were found, the 5g machine was never put into production. Recently, a micro-scale (2g) mixer was developed in Australia (Rath et al. 1990). This 2g unit was designed to be used by wheat breeders for testing varieties as early as the F2 generation, and for evaluating the functional properties of purified protein fractions isolated from flours. However, the increased sensitivity of such a small machine resulted in a characteristically wide curve. It has also been noted that increased variability in mixing results may occur due to operator error and/or environmental inconsistencies resulting from the small sample.

Discussions comparing the moving and fixed-bowl designs lead to studying the machine's output reproducibility and repeatability. Mixograph users have long known that there were differences among instruments as well as between operators and laboratories. Such differences have become quite apparent with the Mixograph's computerization (Wooding and Walker 1992). The official AACC Mixograph method 54-40A includes instructions for checking the machine (AACC 1991).

The moving-bowl models use long coil springs, horizontally arranged, which largely determine the span of the curve, limited by mechanical stops. Variations in the spring length, spring constant, or other mechanical features could cause differences in the peak height for the same flour run on two instruments. Current operating practice does not involve routinely checking the spring on the moving-bowl instrument. However by its nature, the fixed-bowl design encourages routine calibration.

A short study was conducted to check several different Mixographs, varying in age and capacity. Springs or load cells were compared with static loads applied to determine the loads required to span the normal 100% operating range.

Nine moving- and four fixed-bowl Mixographs were tested at three different locations in Manhattan, KS. Their ages varied from less than 2 to more than 40 years. They were tested as is, with no attempt to adjust them. Two moving-bowl units were 35g, six were 10g, and one was a prototype 5g size. There were two each 35g and 10g fixed-bowl units.

A calibration device was mounted onto the Mixograph in place of a bowl (Fig. 1). A horizontal quadrant with a 3.50 inch radius cord track was attached. A cord passed through the track and over a low friction pulley mounted on an adjustable stand. Weights attached to the cord provided known forces whose effect could be noted by recording the pen position on the strip chart for the moving-bowl models or by measuring the load cell output for the fixed-bowl models. The springs on the moving-bowl units were always hooked into the No. 12 position and the weights applied until 100% full scale was reached. For the 35g fixed-bowl machines, 1320g defined the 100% load, and 435g was used for full scale on the 10g models. These values had been shown by past experience to give fixed-bowl mixogram midline curve heights that agreed closely with those from moving-bowl curves using the same flour. These values do not correspond exactly with the 100% values from the moving spring tests. Changing the calibration on a fixed-bowl will in no way affect its linearity. In fact, it is possible to "mathematically" re-calibrate and reanalyze data files, provided the load-cell A/D converter range has not been exceeded.

The results for each stress vs. strain curve were plotted and a

linear regression line calculated. The correlation coefficient, r, indicating goodness of fit, and the equation constants for the predicted linear relationship were obtained. The Y intercept indicated how closely the line approached the theoretical zero force-zero displacement point and the slope was an indication of the spring constant. These constants permitted comparing different machines' sensitivity.

*Moving Bowl*

Regression constants are in Table 1. With one exception, 35MB1, all units had first order (linear) regression r values of 0.998 or better, in spite of an obvious 'lazy S' shape to the data lines (Fig. 2). The slope and intercept also differed. In all cases except 5MB1, the lines do not cross zero. This is probably because the weight of the horizontal spring becomes more significant than the spring constant at low displacement. The relatively good linearity is also rather surprising in light of the changing effective spring lever length as the arm swings through its arc. The regression slopes, proportional to the spring constant, varied over a 7% range for the 10g models. The largest difference was between 10MB3 and 10MB4, both located in the same laboratory. The regression line for 5MB1 most nearly passed through the zero point, perhaps because it was the newest and most carefully made, or perhaps because it was the most recently adjusted.

Variations in Y intercepts, but with relatively constant slopes, indicate that the "zero and 100%" points are different for each Mixograph but that the springs are relatively uniform. Different effective pen arc radii may cause some of the variation. At a normal "peak height", about 60% of full scale, the range among the 10g instruments was from about 60% to about 72% of full scale for the same 250g displacing force (Fig. 2). Likewise, an 800g displacing force could cause from 60% to 69% displacement on different 35g units. If typical, these variations could contribute substantially to claimed lab to lab variations on the same flour sample.

It is interesting to note that the slope ratio for the 10 to 35g models is 3.12, close to but not exactly the reciprocal of the weight ratio, 3.5, which might have been expected if the 10g model had been exactly scaled from the 35g model. The 5g to 10g model ratio is 1.97, much closer to the 2.00 expected, as the 5g unit was relatively recently designed, and based rather closely upon the 10g model.

*Fixed Bowl*

The results for the 35 and 10g fixed-bowl Mixographs and their regression values are shown in Table 1 and Figure3. By virtue of the normal zero and span calibration setup, which should be run before collecting data each day, the 0% and 100% points should coincide for all instruments of the same size.

The linear correlation coefficients, r, are all 0.999, indicating very good linearity, though examination of Figure 3. shows a slight deviation in the case of 10FB2. This may result from mishandling the load cell element, or a small difference in the prototype electronic interface box which excited the load cell, amplified the output, and converted it to digital values.

The linearities of all fixed-bowl versions are as good as or better than the moving-bowl versions. In a real data collection situation, there is some unavoidable friction in the bowl shaft bearing and the moving-bowl also suffers from the pen dragging on the paper, tending to further dampen the swings and making the curves more narrow. Inertial effects also influence the moving-bowl pen trace.

*Conclusions and Recommendations*

For nine moving-bowl Mixographs in three different institutions, representing three different bowl sizes and different ages, there were substantial differences in the force vs. displacement relationships. Although these variations contribute to 'among machine' variations, the use of a simple "quadrant and weight" set, employing new or verified springs, and attention to details such as spring mounting, inter-laboratory variations in Mixograms could be reduced substantially. It is also probable that properly designed and maintained fixed-bowl Mixographs would exhibit less variability than the moving-bowl models. Therefore, a force-displacement standardization procedure and kit should be developed and verified by a collaborative study. Calibrations should be checked daily, and adjustments made as necessary. The check should be made after a warm-up run. A corresponding procedure and apparatus should also be developed for the new direct drive, motor power demand models.

**REFERENCES**


American Association of Cereal Chemists. 1991. Approved Methods of the AACC, 8th ed. Method 54-40A, approved April 1961, revised Oct. 1988. The Association: St. Paul, MN.

Finney, K. F. 1989. A five-gram Mixograph to determine and predict functional properties of wheat flours. Cereal Chem. 66(6):527-530.

Finney, K. F. and Shogren, M. D. 1972. A ten-gram Mixograph for determining and predicting functional properties of wheat flours. Bakers' Digest. 46(2):32-35, 38-42, 77.

Rath, C. R., Gras, P. W., Wrigley, C. W., and Walker, C. E. 1990. Evaluation of dough properties from two grams of flour using the Mixograph principle. Cereal Foods World. 35(6):572-574.

Shogren, M. D. 1990. A short history of the Mixograph. Cereal Foods World. 35(5):480-482.

Swanson, C. O. and Working, E. B. 1933. Testing the quality of flour by the recording dough mixer. Cereal Chem. 10(1):1-29.

Wooding, A. R. and Walker, C. E. 1992. Comparison of alternative recording mechanisms (mobile vs. fixed-bowl) for the 35- and 10-gram Mixographs. Cereal Chem. 69(3):249-253.

# TABLE 1

## Linear Regressions for Mixograph Displacing Force

| Mixograph | r | Y, % | S, %/g |
|---|---|---|---|
| Moving-bowl | | | |
| 35MB1 | 0.986 | 6.12 | 0.079 |
| 35MB2 | 0.999 | 3.76 | 0.071 |
| 10MB1 | 0.998 | 9.23 | 0.228 |
| 10MB2 | 0.998 | 12.37 | 0.240 |
| 10MB3 | 0.998 | 8.86 | 0.231 |
| 10MB4 | 0.999 | 4.27 | 0.227 |
| 10MB5 | 0.999 | 6.27 | 0.241 |
| 10MB6 | 0.999 | 2.29 | 0.239 |
| 5MB1 | 0.998 | 0.92 | 0.460 |
| Fixed-bowl | | | |
| 35FB1 | 0.999 | 0.68 | 0.075 |
| 35FB2 | 0.999 | -3.75 | 0.078 |
| 10FB1 | 0.999 | -0.59 | 0.232 |
| 10FB2 | 0.999 | -3.18 | 0.236 |

r = correlation coefficient; Y = intercept; S = slope

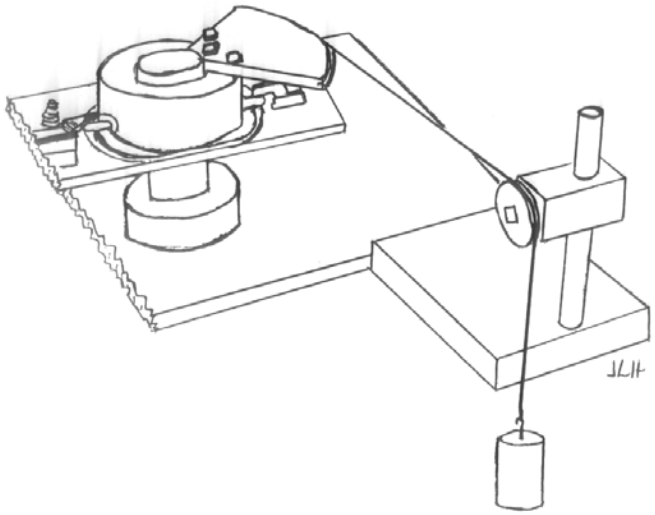


Fig. 1 Mixograph force calibration quadrant.

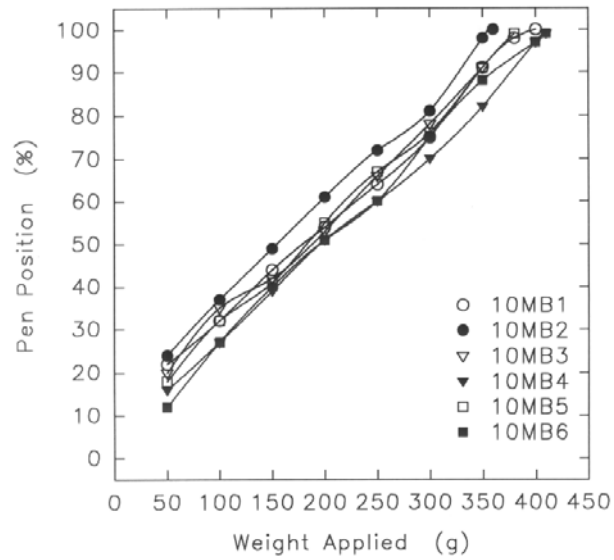



Fig. 2 Pen displacement as a function of load applied to six 10g moving-bowl Mixograph arms.

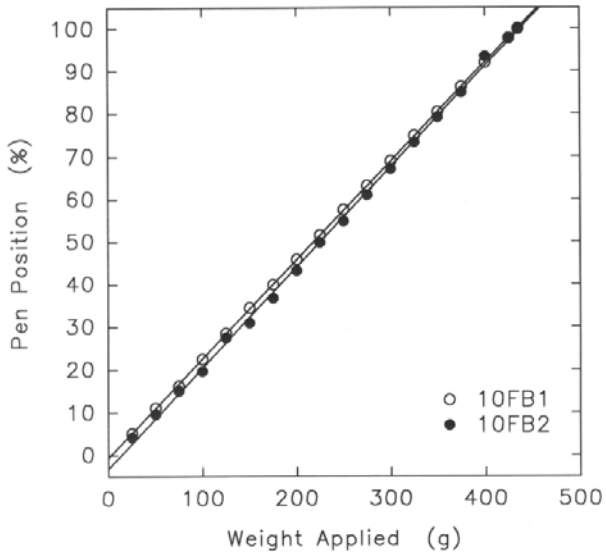



Fig. 3 Torque sensed by the load cell as a function of the load applied to two 10g fixed-bowl Mixograph arms.

# MIXOGRAPH APPLICATIONS

# Chapter 12
# EFFECTS OF BAKING INGREDIENTS AND ADDITIVES ON MIXOGRAMS

J.G. Ponte, Jr.[1] and M.E. Ingelin[2]

[1]Department of Grain Science and Industry, Kansas State University, Emeritus, Manhattan, KS, USA, and [2]Agriculture Canada Winnipeg Research Station, Winnipeg, MB, Canada.

Since the inception of the Mixograph, its primary use has been to test and evaluate the quality and functionality of wheats and flours for cereal-based food production. Generally, the instrument has been eminently successful in this purpose, as indicated in other chapters of this book.

Another important Mixograph application has been to determine the various ingredient and additive effects on dough rheological properties and to predict the influence of these effects on end-use products. Conducting such tests on the Mixograph is obviously quicker and less expensive than carrying out traditional baking tests, although it is recognized that the latter still remains the final arbiter of quality. Small samples are used with the Mixograph and the resulting curves can be measured rather precisely. The underlying premise of any rheological study, including the Mixograph, is that the results correlate well to baking test results.

The Mixograph has been used to evaluate ingredient and additive functionality in dough systems and also it has been a useful tool in addressing a variety of applied research problems. This chapter will review and discuss a broad spectrum of studies that have been done.

## *EFFECTS OF GLUTEN PROTEINS*

A wide variety of protein materials have been studied with the Mixograph. Most of the work has dealt with the gluten and gluten fractions and their effects on dough properties.

Gluten addition to dough generally is known to provide "strengthening". Lang and co-workers (1992) found that increasing the gluten concentration (control, modified with soy lecithin, and enhanced with vitamins and emulsifier) increased mixogram peak height and also increased work input to reach full development. However, peak time decreased with increased gluten concentrations. Wang and Ponte (1995) reported that flash-dried gluten led to longer peak times and slightly wilder curves than did the addition of freeze-dried or fresh wet glutens to doughs. These results related well to baking test results.

Neufeld and Walker (1990) devised a Mixograph method to evaluate commercial glutens involving a model dough system with wheat starch, a water-solubles replacer, and potassium iodate; test glutens were added in sufficient amounts to provide 15% protein. This method could distinguish among glutens of acceptable and unacceptable quality and maybe a viable rapid alternative to a baking test for the vital gluten manufacturer. Figure 1. shows a comparison between Mixograph predicted values (percent of daily standard values) with results of actual pup-loaf bake tests; an $r^2$ value of 0.98 was achieved.

Butaki and Dronzek (1979) prepared freeze-dried glutens from four wheat varieties and compared these using the Mixograph. Glutens from strong wheats showed greater resistance to stretching and over mixing (breakdown) than glutens from weak flours. Small gluten additions from the four wheat varieties strengthened the doughs in the same order as the mixing strengths of the flours. Wooton et al (1982) studied the microbial deterioration of wet gluten stored at 17°C and monitored changes using the Mixograph and the baking test. Maximum dough stiffness was relatively unaffected by storage time (provided deterioration after 40 hr was not excessive), but optimum mix times decreased with increasing storage time.

Many researchs have studied gluten structure and functionality by fractionating gluten into various components and subjecting the components to tests on the Mixograph. Dougherty et al (1990) separated proteins from 14 wheat samples by two-dimensional electrophoresis and found that three individual proteins correlated highly with Mixograph peak time. Figure 2. illustrates the relationship between electrophoretic integrated intensity of a polypeptide, identified as Spot 17, and Mixograph peak time; an r value of -0.893 was obtained.

Lookhart and co-workers (1993) evaluated the breadmaking performance, as measured by the Mixograph and baking tests, to high molecular weight glutenin and gliadin protein components. Randall et al (1993) examined the relationships between large glutenin subunit composition and quality of 38 South African wheats, using the Mixograph and other parameters. They found that certain glutenins were related to desirable rheological properties, whereas others were not. Lawrence et al (1988) studied wheat lines lacking in high molecular subunits in regards to the Mixograph values, protein content, and bake test. The removal of high molecular glutenin subunits led to a progressive and dramatic loss of breadmaking quality. Other workers have also drawn various conclusions about the functionality of the gluten fractions based on mixogram observations (Lee and MacRitchie 1971, Preston and Tipples 1980, MacRitchie 1987, Dreese and Hoseney 1990, Dhaliwal and MacRitchie 1990, MacRitchie et al 1991, Primard et al 1991, Gupta et al 1992, Dong et al 1992, Bekes et al 1994, and Johansson and Svensson 1995).

## *EFFECTS OF NONGLUTEN PROTEINS*

Mixograph studies with a focus on protein-rich materials other than gluten have also been reported in the literature. Typically, these investigations have been concerned with enhancement in flour and dough systems to improve protein quantity. Experience has shown that the addition of protein-rich materials to doughs leads to adverse or weakening effects as measured by

Mixograph parameters particularly, mixing time and tolerance. Fleming and Sosulski (1977) worked with soy, sunflower, fababean, and field-pea protein concentrates; Okezie and Dobo (1980) studied winged bean with mixtures of triticale and wheat flours; El-Minyawi and Zabik (1981) used cottonseed flour; and Sathe et al (1981) added Great Northern bean protein concentrate to dough. The surfactant addition such as sodium stearoyl-2-lactylate (SSL) to composite flours can, to some extent, overcome the dough weakening effects of the non-farinaceous materials (Fleming and Sosulski 1974, Okezie and Dobo 1980).

### *EFFECTS OF OXIDATION ON DOUGH PROPERTIES*

With the decreased use of bromate in breadmaking, potential replacement oxidant systems have been investigated extensively. The Mixograph has had a role in studying oxidant effects on dough properties.

Ascorbic acid has long been known to exert an improving effect on dough quality (Jørgensen 1945). Weak and co-workers (1977) tested the effects of ascorbic acid and other compounds on mixogram properties. They found that high ascorbic acid amounts (200ppm) reduced mixogram peak height. When 30 ppm of potassium iodate or azodicarbonamide (ADA) was used, dough breakdown after peak was accelerated. This effect was also present when potassium bromate was used, provided the pH was below 4.7. It was concluded that, because its effect would be delayed until dough pH had dropped during fermentaion, bromate could be used in combination with cysteine, a reducing agent.

Dong and Hoseney (1995) used a rheometer to study the ascorbic acid effect. A Mixograph was used to determine proper mix time and absorption for the flour under study. After these parameters were determined, the Mixograph was used to develop the doughs that were tested in the rheometer.

When glutathione was added, the resulting dough had a lower G' than a control dough having no additive. When ascorbic acid was added in combination with glutathione, measured G' was restored to the control level. One of the objectives in this study was to provide evidence that the ascorbic acid improver effect was mediated by the enzyme glutathione dehydrogenase. After the water soluble fraction was boiled to inactivate any enzymes present, the flour sample was reconstituted and reanalyzed. No ascorbic acid improver effect was evident in doughs from the reconstituted flour.

### *EFFECTS OF SALT ON DOUGH MIXING*

Commercial bakers have long known that salt in dough lengthens mixing time. Longer mixing times slow processing, require more energy, and increase wear on the dough mixers. For this reason, bakers delay salt addition until late in the mixing cycle. Mixograph studies support this connection of salt and mix time and have shown that peak height also increases (Lang et al 1992, He et al 1992). Work at the Canadian Cereal Research Center in Winnipeg illustrates the salt effect (Fig. 3). Danno and Hoseney (1982) believed that salt delays flour hydration by shielding flour protein charges. This charge shielding makes the proteins less hydrophilic and lengthens mixing time. Not all salts have the same effect on mixograms. He et al (1992) found that sodium iodate also increased peak height, but reduced mix time. Calcium chloride had no effect on mixing time.

### *EFFECTS OF FIBER INGREDIENTS*

Recognition that fiber is an important dietary component, but often lacking in the diets of industrialized societies has led in recent years to a proliferation of fiber-rich foods, including many cereal-based products. Considerable research has been done to develop numerous fiber materials from various plant sources, and the Mixograph has had a role in the evaluation and characterization of these materials.

Fiber addition, brans from wheat, triticale, and millet to dough typically increases water absorption (Haridas and Malini 1991, Halim and Lorenz 1985). Decreased mixing times have been reported with bran incorporation. Cadden et al (1983) investigated the properties and physiological response of rats to breads made with 7.5% of the wheat flour replaced with field pea, flax or sunflower hulls, wheat bran, or cellulose. These workers reported that flax and sunflower hulls in particular had adverse effects on dough Mixograph properties.

Jasberg et al (1989) used alkaline peroxide-treated lignocellulose as a fiber ingredient and found increased Mixograph peak height and absorption. Up to 10% of this ingredient could replace flour in bread dough with essentially no change in loaf volume. Various amounts of apple fiber and cellulose were added to Mixograph doughs (Chen et al 1988). Table 1. summarizes their observation that absorption increased and optimum mixing time tended to increase with increased fiber. They also noted that fibril formation, as indicated by peak height, decreased with increased fiber amount, suggesting that the fibers slowed the rates of hydration and gluten development. Venkateswara et al (1985) utilized levels of 0.5 to 1.5% guar gum in their doughs and found that water absorption increased and dough development time decreased, but stability and dough consistency were unaffected.

### *EFFECTS OF ENZYME SYSTEMS*

Some enzyme systems are known to exert effects on dough rheological properties, with ramifications on dough handling and mechanical processing, aside from reflecting inherent, fundamental attributes of dough. The Mixograph has been a useful tool in studying changes in dough properties as a function of enzymatic activity.

Shiiba et al (1991) separated wheat lipoxygenase into three major components and tested flour treated with the purified lipoxygenases using the Mixograph. The lipoxygenase isoenzymes caused shorter dough development times and less resistance after peak time compared to control; one of the enzymes exhibited better baking properties than the others. Hoseney et al (1980) studied lipoxygenase from soy flour and found increased mixing tolerance and improved rheological dough properties when this enzyme system was added. Improvements in dough stability from enzyme-active soy flour are demonstrated in Fig. 4. They suggested that lipoxygenase affects mixing tolerance by creating a free radical on some lipids that compete for activated double-bond compounds native to flour or developed by some oxidants.

Singh et al (1978) compared commercial enzyme preparations in baking tests and on the Mixograph and reported various effects on dough mixing time. Mixing tolerance generally was increased with the enzymes, but dough strength as measured by the mixogram height decreased. Woods et al (1980) conducted studies on effects of a crude protease preparation from *Saccharomyces carlsbergensis* on dough strength. Peak time and height, and band width decreased with added protease. The enzyme effects were likened to that of enzymes derived from *Aspergillus oryzae*. Kaufman and Fennema (1987) evaluated sulphydryl oxidase, an enzyme that catalyses disulphide bonds in dough. They found that the enzyme was unable to stregthen dough and attributed this to its inability to function in the system tested, or to its known inability to catalyse thiol-disulphide interchange reactions.

### *EFFECTS OF SURFACTANTS*

Among the important ingredient categories in cereal-based foods, perhaps especially bakery foods, are surfactants. These materials perform a number of functions, but in bakery foods production, they typically promote either crumb softening and/or dough strengthening. Researchers often have utilized the Mixograph to study the role of surfactants in cereal-based products.

In 1974, Fleming and Sosulski, as noted earlier, reported on the improving effects of various surfactants in dough systems containing soy flour. Watson and Walker (1986) studied sucrose esters in dough and found that these materials increased mixogram peak times, in contrast to the Farinograph, which yielded reduced peak times and increased mixing endurance. Lang et al (1992) showed that SSL increased mixogram peak time, but had little effect on peak height. Mahdi and Dawoud (1986) explored the interactions between surfactants and oxidants in Mixograph dough systems. They indicated that surfactants alone generally increased mixing time and reduced dough breakdown, and in mixtures, the surfactants accounted for more of the improving effects than the oxidants.

Taha (1990) blended semolina from three durum wheat cultivars with several SSL levels and examined the resulting doughs with the Mixograph as well as the Farinograph. SSL at all levels markedly delayed dough development time and increased stability. Taha et al (1992) prepared flat noodles from durum semolina or from blends of semolina with yellow corn flour, soy flour, and defatted soy flour. Using a micro-Mixograph method, they found that the non-semolina materials increased dough mixing strength stability, dough development time, and curve area.

### *EFFECTS OF pH ON DOUGH PROPERTIES*

The dough pH is known to influence many dough properties, including rheological attributes, some of which have been assessed with the Mixograph. Hoseney and Brown (1983) used the Mixograph to investigate the response of mixing parameters to low pH values. Their study focused on the parameter of mixing stability, which was equated with mixogram tail width 3 min after the peak. They found that mixing stability was proportional to pH, and the higher the pH, the more stable the dough. Unlike the thin tail produced during overmixing, pH changes were found to be reversible, thus increasing dough pH could widen thin tails. Kerr et al (1993) reported that doughs from different flours had varying response to pH changes. They related these differences to different protein compositions and/or strength of protein interactions.

Holmes and Hoseney (1987) used a combination of chemical leavening and yeast in breadmaking and utilized the Mixograph to characterize the effects of ions on mixograms. The results corresponded to the anionic lyotropic series, and a selected ions baking study of this series supported the Mixograph results.

Miki et al (1982) studied sodium chloride and pH effects on the rheological properties of synthetic doughs with the aid of the Mixograph. Dough development time of salt-free dough increased and the weakening rate decreased with pH. Dough development accelerated in dough with added salt when pH increased from 4.1 to 5.1 and slowed slightly above pH 5.8. Maximum dough consistency increased with higher pH, and maximum weakening rates occurred for doughs of pH 5.1 and 5.8.

### *EFFECTS OF FLAVOR INGREDIENTS*

Yeasted doughs of differing types may include certain flavor ingredients that can potentially influence dough properties. Such effects have been investigated with the Mixograph. Indrani et al (1992) and Venkateswara et al (1992) added onion and garlic extracts, respectively, to doughs tested in the Mixograph. These researchers found that the area under the mixogram was significantly reduced with both extracts. Such reductions in mixogram area could be caused by decreasing mix time and/or reduction in peak height.

### *NONINGREDIENT APPLIED RESEARCH*

The previous sections have dealt primarily with reported studies involving the use of the Mixograph to evaluate ingredients and additives in various dough systems. The Mixograph also has served as a useful and versatile tool in addressing a wide variety of research problems under the broad category of cereal science. This section summarizes some of the work done.

Uprety et al (1976) studied effects of soil nitrogen fertility on wheat yield and quality. For Mexican varieties, mixing time and development area were not affected appreciably by nitrogen application, but mixing tolerance decreased, and other mixogram characteristics increased with increased nitrogen levels. Dough properties of Indian wheats were less affected by nitrogen levels. Kosmolak and Crowle (1980) were also concerned with nitrogen fertilization effects. For Canadian wheats, they found that Mixograph development time decreased and water absorption increased as protein content increased with more nitrogen application.

Lorenz (1974) examined the influence of various atmospheric pressures on dough properties with the Mixograph. It was reported that peak height, length of curve to peak height, time to peak, and curve area generally increased as elevation increased. Operation of the Mixograph was affected by changes in atmospheric pressure, and this should be considered when examining Mixograph data.

Pentosan effects on dough properties were studied by Vanhamel et al (1993). These researchers added high molecular weight rye pentosans, either as a dry powder or pre-soaked, to dough and found that the pentosans, particularly when presoaked, greatly increased peak height as well as curve area (Fig. 5). Biliaderis et al (1992) also used the Mixograph as a tool to study pentosans in wheat flour. They concluded that considerable variation exists in molecular size and physical properties of pentosans of 1B/1R translocation wheats, which may influence dough development and baking attributes.

Doescher and Hoseney (1985) utilized the Mixograph to evaluate 11 commercial cracker flours and then went on to study changes in cracker sponges during fermentation using the Mixograph. They observed decreasing viscosity, with much of the rheological change taking place during the early part of fermentation at pH greater than 5.2.

The Mixograph has been used often to predict water absorption in various dough systems. Oh et al (1986) found that the Mixograph provided a good estimate of absorption in a dry-noodle dough, and accurately measured changes in absorption in these doughs caused by differences in starch damage and flour granulation. Mixograms obtained from mixing pasta doughs from semolina and farina differ considerably from conventional bread flour mixograms (Fig. 6). A rheological property of pragmatic interest is pasta viscoelasticity, which was addressed by Kovacs et al (1995). They developed a test for pasta disc viscoelasticity to predict cooking quality and found a good correlation between this test and Mixograph values. Rogers and Hoseney (1987) developed a modified Mixograph procedure to determine optimum water absorption for saltine cracker doughs.

Problems from preharvest sprouting in wheat were investigated by Kulp et al (1983). These workers showed a gradual weakening of doughs on the Mixograph with increased sprouting, but little effects on mixing time and absorptions.

Bettge et al (1989) used techniques based on air aspiration to separate 37 commercial wheats into fractions varying in kernel density and subjected these samples to different tests, including the Mixograph. Their findings indicated that the less dense fractions exhibited higher Mixograph absorption.

***MEASUREMENT OF "STICKY DOUGH" PROPERTIES***

As in other industries, commercial bakeries are increasingly automated and run at faster processing rates. Bakeries utilize a functionally important raw material that is biologically derived, flour. The wheat from which the flour is milled from is subject to changes in quality based on cultivar and environmental considerations. Changes in flour quality can be expressed in the dough during and after mixing; dough mixing times and absorption can be altered, and the dough can exhibit changes in its resistance to extension, extensibility, and other textural characteristics. Without some capacity for feedback and flexibility, a bakery's automated system will be unable to successfully process such doughs.

An example of such a problem is the occurrence of "sticky doughs". These doughs are excessively adhesive, which causes them to cling to rounders, sheeting rolls, and other equipment. When dough processing is compromised in this way, large quantities of dough can accumulate on equipment and on the bakery floor. Cereal chemists have used the Mixograph extensively to study the sticky dough problem.

Weegels et al (1995) ran flour and water mixograms after adding low molecular weight, nongluten protein fractions. These extracts were precipitated using ammonium sulfate from an extraction solution containing acetic acid-urea-cetyltrimethyl ammonium bromide. These fractions were extracted from the same flour being tested. Farinograph absorptions were used to run these Mixograph tests. When these fractions were added at the 0.2% w/w level, the doughs became sticky and difficult to manipulate for subsequent rheological testing.

In order to improve disease resistance, rye x wheat chromosome combinations have been added to many recent wheat cultivars. Shortly after these cultivars were introduced, they were criticized severely for causing sticky dough difficulties. Dhaliwal et al (1988) found that wheats having the 1B/1R translocation had lower SDS sedimentaion volumes and shorter Mixograph mix times. They did not necessarily consider the shorter mix times to be problematic. Pena et al (1990) found no decrease in mixing tolerance from the 1B/1R translocation. These investigators used absorptions based on protein regression and measured mix tolerance by the descending angle following the mix peak. With their system, if the descending angle was more than 350, mixing tolerance was poor and received a score of 1. If, on the other hand, the descending angle was 50 or less, mixing tolerance was good and scored 6. The other scores were distributed between these values at 70 increments. Results showed that mixing tolerances were similar between translocated and nontranslocated wheats. Some of the translocated wheats had the highest measured tolerance scores. These workers concluded that 1B/1R wheats do not necessarily lead to sticky doughs when mixing is done using medium speed mixers.

Chen and Hoseney (1995) separated out water-soluble components from wheat cultivars in an attempt to isolate the compound responsible for sticky dough production. By running mixograms using various combinations of the reconstituted water-soluble and insoluble fractions, they demonstrated that the causative agent was present in the water-soluble fraction. After further testing, these investigators concluded that the sticky dough compound was ferulic acid, ester-linked to a short carbohydrate chain.

Dhaliwal and MacRitchie (1990) also investigated the importance of the water-soluble fraction by mixing doughs to peak at constant absorption (60%). They found that decreasing the amount of water-solubles in reconstitued doughs by 25% increased mixogram width and tolerance.

Dhaliwal et al (1990) defined a stickiness score as follows: (0) dough can be removed from bowl cleanly, no sticking; (1) dough sticks slightly; (2) dough can be removed in one piece if handled slowly; (3) dough can not be removed in one piece; (4) dough shows excessive stickiness. According to this scoring system, adding an additional 15% water-solubles to the reconstituted doughs increased stickiness.

Gluten also was added to the reconstituted doughs. When glutens from translocated lines were added to dough from nontranslocated lines, mixogram height and width decreased. These researchers concluded that this change was due to a shift from polymeric to monomeric protein units.

Wang et al (1994) further developed the stickiness evaluation described above. They attempted to standardize the stickiness scoring system using clear descriptions and photographs for examples. Farinograph absorptions were used for their Mixograph evaluations. This work focused on the effects of over mixing on dough stickiness. Translocated and control cultivars were tested at different multiples of Mixograph mixing times: 1.1, 1.3, and 1.5. Ten min mixing times also were used. These workers found that doughs from translocated cultivars showed evidence of over mixing after shorter times compared to doughs from the control cultivars. Sun 89D produced sticky dough no matter what the mixing time. They concluded that based on stickiness, a mix time of 1.2x Mixograph mixing time was best for separating the control lines from those containing the rye translocation.

Carver and Rayburn (1995) also compared mixograms from wheat cultivars having translocations to those without. By carefully arranging the cultivar crosses, they attempted to control all variables in the tested genomes except the presence or absence of the T1BL/1RS translocation. It was observed that the translocated cultivars were associated with a decrease in Mixograph score and band width. Thus, these cultivars were made sensitive to overmixing. They concluded that, in the homozygous condition, the T1BL/1RS leads to inferior physical dough properties.

***ACKNOWLEGEMENT***

This paper is published as contribution no. 97-281-B. Kansas Agricultural Experiment Station, Manhattan 66506.

***REFERENCES***

Bekes, F., Gras, P. W., Gupta, R. B., Hickman, D. R., and Tatham, A. S. 1994. Effects of a high glutenin (1B x 20) on the dough mixing properties of wheat flour. J. Cereal Sci. 19(1):3-7.

Bettge, A., Rubenthaler, G. L., and Pomeranz, Y. 1989. Air-aspirated wheat cleaning in grading and in separation by functional properties. Cereal Chem. 66(1):15-18, 22.

Biliaderis, C. G., Izydorczyk, M. S., Lukow, O. M., and Bushuk, W. 1992. Pentosans in flours of 1B/1R translocation wheats. Cereal Chem. 69(2):226-228.

Butaki, R. C. and Dronzek, B. 1979. Comparison of gluten properties of four wheat varieties. Cereal Chem. 56(3):159-161.

Cadden,, A. M., Sosulski, F. W., and Olson, J. P. 1983. Physiological response of rats to high fiber bread diets containing several sources of hulls or brans. J. Food Sci. 48(4):1151-1156.

Carver, B. F. and Rayburn, A. L. 1995. Comparison of related wheat stocks possessing 1B, or T1BL, 1RS chromosones: grain and flour quality. Crop Sci. 35(5):1316-1321.

Chen, H., Rubenthaler, G. L., and Schanus, E. G. 1988. Effect of apple fiber and cellulose on the physical properties of wheat flour. J. Food Sci. 53(1):304-305.

Chen, W. Z. and Hoseney, R.C. 1995. Wheat flour compound that produces sticky dough: Isolation and identification. J. Cereal Sci. 60(3):434-437.

Danno, G. and Hoseney, R. C. 1982. Effect of sodium chloride and sodium dodecyl sulfate on Mixograph properties. Cereal Chem. 59(3):202-204.

Dhaliwal, A. S. and MacRitchie, F. 1990. Contributions of protein fractions to dough handling properties of wheat-rye translocation cultivars. J. Cereal Sci. 12(2):113-122.

Dhaliwal, A. S., Mares, D. J., Marshall, D. R., and Skerritt, J. H. 1988. Protein composition and pentosan content in relation to dough stickiness of 1B/1R translocation wheats. Cereal Chem. 65(2):143-149.

Doescher, L. C. and Hoseney, R. C. 1985. Evaluation of commercial cracker flours by test baking and study of changes occurring during sponge fermentation. J. Cereal Sci. 3(3):261-270.

Dong, H., Sears, R. G., Cox, T. S., Hoseney, R. C., Lookhart, G. L., and Shogren M. D. 1992. Relationships between protein composition and Mixograph and loaf characteristics in wheat. Cereal Chem. 69(2):132-136.

Dong, W. and Hoseney, R. C. 1995. Effects of certain breadmaking oxidants and reducing agents on dough rheological properties. Cereal Chem. 72(1):58-64.

Dougherty, D. A., Wehling, R. L., Zeece, M. G., and Partridge, J. E. 1990. Evaluation of selected baking quality factors of hard red winter wheat flours by two-dimensional electrophoresis. Cereal Chem. 67(6):564-569.

Dreese, P. C. and Hoseney, R. C. 1990. The effect of water-extracted solubles from gluten on its baking and rheological properties. Cereal Chem. 67(4):400-404.

El-Minyawi, M. A. and Zabik, M. E. 1981. Cottonseed flour's functionality in Egyptian baladi bread. Cereal Chem. 58(5):413-417.

Fleming, S. E. and Sosulski, F. W. 1977. Breadmaking properties of four concentrated plant proteins. Cereal Chem. 54(5):1124-1140.

Fleming, S. E. and Sosulski, F. W. 1974. Dough conditioners in wheat-soy-gluten breads. Can. Inst. Food Sci.Technol. J. 7(1):51-55.

Gupta, R. B., Batey, I. L., and MacRitchie, F. 1992. Relationships betweem protein composition and functional properties of wheat flours. Cereal Chem. 69(2):125-131.

Halim, M. A. and Lorenz, K. 1985. High fiber Sudanese breads. Nutr. Rep.Intl. 31:91.

Haridas, R. P. and Malini, R. H. 1991. Effect of incorporating wheat bran on the rheological characteristics and bread making quality of flour. J. Food Sci. Technol. India 28(2):92-97.

He, H., Roach, R. R., and Hoseney, R. C. 1992. Effect of nonchaotropic salts on breadmaking properties. Cereal Chem. 69(4):366-371.

Holmes, J. T. and Hoseney, R. C. 1987. Effect of certain ions on breadmaking properties. Cereal Chem. 64(5):343-348.

Hoseney, R. C. and Brown, R. A. 1983. Mixograph studies. V. Effect of pH. Cereal Chem. 60(2):124-126.

Hoseney, R. C., Rao, H., Faubion, J. M., and Sidhu, J. S. 1980. Mixograph studies. IV. The mechanism by which lipoxygenase increases tolerance. Cereal Chem. 57(3):163-166.

Indrani, D., Savithri, G. D., and Venkateswara, R. G. 1992. Effect of onion extract on the rheological and breadmaking characteristics of wheat flour. J. Food Sci. Technol. India 29(3):150-152.

Jasberg, B. K., Gould, J. M., Warner, K., and Navicks, L. L. 1989. High fiber, non-caloric flour substitute for baked goods. Effects of alkaline peroxide-treated lignocellulose on dough properties. Cereal Chem. 66(3):205-209.

Johansson, E. and Svensson, G. 1995. Contribution of the high molecular weight glutenin subunit 21* to breadmaking quality of Swedish wheats. Cereal Chem. 72(3):287-290.

Jørgensen, H. 1945. Studies on the Nature of the Bromate Effect. Oxford University Press, London.

Kaufman, S. P. and Fennema, O. 1987. Evaluation of a sulfhydryl oxidase as a strengthening agent for wheat flour dough. Cereal Chem. 64(3):172-176.

Kerr, C., Hoseney, R. C., and Faubion, J. M. 1993. Mixograph studies. VI. Combined effects of charge (pH), activated double bond compounds, and oxidants on dough mixing properties. Cereal Chem. 70(6):633-636.

Kosmolak, F. G. and Crowle, W. L. 1980. An effect of nitrogen fertilization on the agronomic traits and dough mixing strength of five Canadian hard red spring wheat cultivars. Can. J. Plant Sci. 60(4):1071-1076.

Kovacs, M. I. P., Noll, J. S., Dahlke, G., and Leisle, D. 1995. Pasta viscoelasticity: Its usefulness in the Canadian durum wheat breeding program. J. Cereal Sci. 22(2):115-121.

Kulp, K., Roewe-Smith, P., and Lorenz, K. 1983. Preharvest sprouting of winter wheat. I. Rheological properties of flours and physicochemical characteristics of starches. Cereal Chem. 60(5):355-359.

Lang, C. E., Neises, E. K., and Walker, C. E. 1992. Effects of additives on flour-water dough mixograms. Cereal Chem. 69(6):587-591.

Lawrence, G. J., MacRitchie, F., and Wrigley, C. W. 1988. Dough and baking quality of wheat lines deficient in glutenin subunits controlled by the Glu-A1, Glu-B1 and Glu-D1 loci. J. Cereal Sci. 7(2):109-112.

Lee, J. W. and MacRitchie, F. 1971. The effect of gluten protein fractions on dough properties. Cereal Chem. 48(6):620-625.

Lookhart, G. L., Martin, M. L., Mosleth, E., Uhlen, A. K., and Hoseney, R. C. 1993. Comparison of high-molecular weight subunits of glutenin and baking performance of flours varying in bread-making quality. Lebensm.-Wiss. u.-Technol. 26(4):301-306.

Lorenz, K. 1974. Mixogram characteristics as affected by varying atmospheric pressures. Cereal Sci. Today 19:322.

MacRitchie, F. 1987. Evaluation of contributions from wheat protein fractions to dough mixing and breadmaking. J. Cereal Sci. 6(3):259-268.

MacRitchie, F., Kasarda,D. D., and Kusmicky, D. D. 1991. Characterization of wheat protein fractions differing in contributions to breadmaking quality. Cereal Chem. 68(2):122-130.

Mahdi, J. G. H. and Dawoud, H. M. 1986. The combined effect of surfactants and oxidants on dough rheology. Iraqui J. Agric. Sci. 4(4):37-48.

Miki, E., Matsumoto, S., and Yonezawa, D. 1982. Effects of sodium chloride and pH on the rheological properties of synthetic flour dough. J. Japanese Soc. Food Sci. Technol. 29(6):353-358.

Neufeld, K. J. and Walker, C. E. 1990. Evaluation of commercial wheat gluten using the Mixograph. Cereal Foods World 35(7):667-669.

Oh, N. H., Seib, P. A., Finney, K. F., and Pomeranz, Y. 1986. Noodles. V. Determination of optimum water absorption of flour to prepare Oriental noodles. Cereal Chem. 63(2):93-96.

Okezie, B. O. and Dobo, S. B. 1980. Rheological characteristics of winged bean composite flours. Bakers Dig. 54(1):35-41.

Pena, R. J., Amaya, A., Rajaram, S., and Mujeeb-Kazi, A. 1990. Variation in quality characteristics associated with some spring 1B/1R translocation wheats. J. Cereal Sci. 12(2):105-112.

Primard, S., Graybosch, R., Peterson, C. J., and Lee, J. H. 1991. Relationships between gluten protein composition and quality characteristics in flour populations of high-protein, hard red winter wheat. Cereal Chem. 68(3):305-312.

Preston, K. R. and Tipples, K. H. 1980. Effects of acid-soluble and acid-insoluble gluten proteins on the rheological and baking properties of wheat flours. Cereal Chem. 57(5):314-320.

Randall, P. G., Manley, M., McGill, A. E. J., and Taylor, J. R. N. 1993. Relationship between high Mr subunits of glutenin of South African wheats and end-use quality. J. Cereal Sci. 18(3):251-258.

Rogers, D. E., and Hoseney, R. C. 1987. Test to determine the optimum water absorption for saltine cracker doughs. Cereal Chem. 64(6):370-372.

Sathe, S. K., Ponte, J. G., Jr., Rangnekar, P. D., and Salunkhe, D. K. 1981. Effects of additions of Great Northern bean flour and protein concentrates on rheological properties of dough and baking quality of bread. Cereal Chem. 58(2):97-100.

Shiiba, K., Negishi, Y., Okada, K., and Nagao, S. 1991. Purification and characterization of lipoxygenase isozymes from wheat germ. Cereal Chem. 68(2):115-122.

Singh, R. P., Singh, G. P., and Bains, G. S. 1978. Baking response of Punjab wheats to proteolytic supplementaion. J. Food Sci. Technol. India 15(6):259-263.

Taha, S. A. 1990. Effect of sodium stearoyl-2-lactylate on some quality parameters of past made from durum wheat semolina. Cereal Res. Comm. 18(4):321-327.

Taha, S. A., Acs, E., and Sagi, F. 1992. Evaluation of economical pasta products prepared from durum semolina/yellow cornflour/soy flour mixtures. I. Mixing properties, chemical composition and colour compounds. Acta Aliment. 21(2):153-162.

Uprety, D. C., Bhardwaj, R. B. L., and Abrol, Y. P. 1976. Soil nitrogen fertility levels and wheat grain yield and quality. Bull Grain Technol. 14(2):97-106.

Vanhamel, S., Cleemput, G., Delcour, J. A., Nys, M., and Darius, P. L. 1993. Physicochemical and functional properties of rye nonstarch polysaccharides. IV. The effect of high molecular weight water-soluble pentosans on wheat-bread quality in a straight dough procedure. Cereal Chem. 70(3):306-311.

Venkateswara, R. G., Indrani, D., and Shurpalekar, S. R. 1985. Guar gum as an additive for improving the bread making

quality of wheat flours. J. Food Sci. Technol. India 22(2):101-104.
Venkateswara, R. G., Rao, G., Savithri, G. D., and Indrani, D. 1992. Studies on the use of garlic in bread. J. Food Sci. Technol. India 29(3):147-149.
Wang, S. M., Watts, B. M., Betker, S. E., Lukow, O. M., and Bushuk, W. 1994. A sensory method of dough stickiness measurement. Cereal Foods World 39(11): 831-834.
Wang, Z. J. and Ponte, J. G., Jr. 1995. Storage stability of gluten-fortified frozen dough. Cereal Foods World 40(11):827-831.
Watson, K. S. and Walker, C. E. 1986. The effect of sucrose esters on flour-water dough mixing characteristics. Cereal Chem. 63(1):62-64.
Weak, E. D., Hoseney, R. C., Seib, P. A., and Biag, M. 1977. Mixograph studies. I. Effect of certain compounds on mixing properties. Cereal Chem. 54(4):794-802.
Weegels, L., Orsel, R., Van de Pijpekamp, A. M., Lichtendonk, W. J., Hamer, R. J., and Schofield, J. D. 1995. Functional properties of low Mr wheat proteins. II. Effects on dough properties. J. Cereal Sci. 21(2):117-126.
Woods, F. C., Bruinsma, B. L., and Kinsella, J. E. 1980. Note on the effects of protease from Saccharomyces carlbergensis on dough strength. Cereal Chem. 57(4):290-293.
Wooton, M., Weaver, S. W., Gras, P. W., and Wrigley, C. W. 1982. Microbial deterioration of wet gluten and its effects on gluten properties and bread quality. Food Technol. Australia 34(5):248, 250-252.

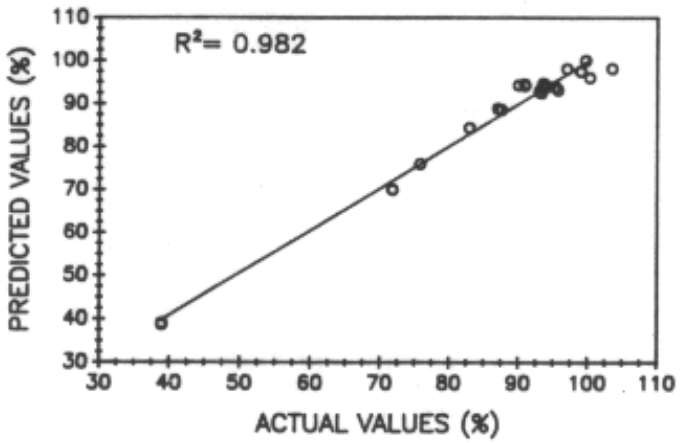



Fig. 1. Pup loaf volumes predicted by Mixograph test compared to actual values. (Neufeld and Walker 1990).

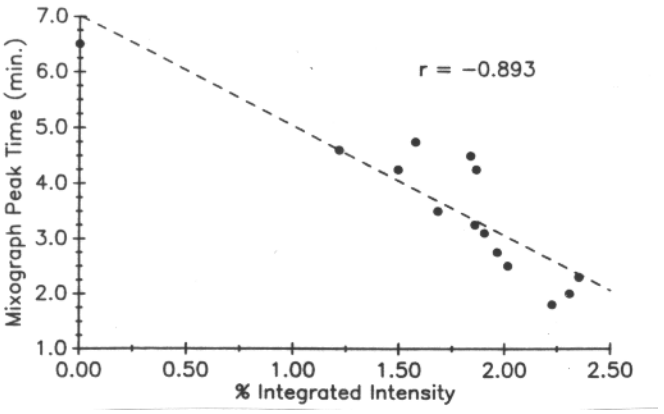



Fig. 2. Relationship between integrated intensity of the endosperm polypeptide identified as Spot 17 and Mixograph peak time for 14 wheat varieties. (Dougherty et al. 1990).

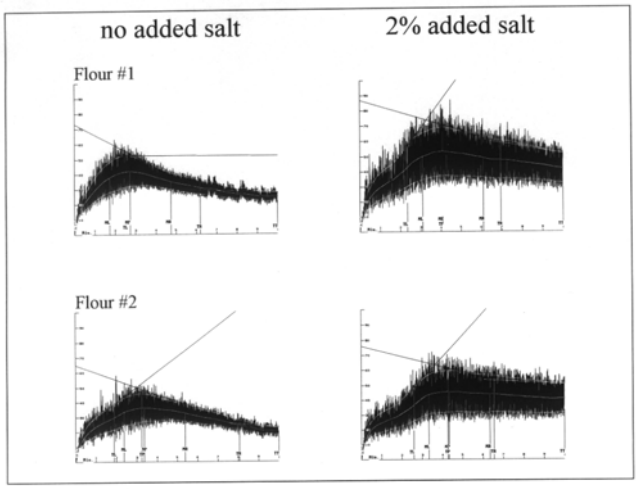



Fig. 3. Effect of 2% sodium chloride on mixograms.

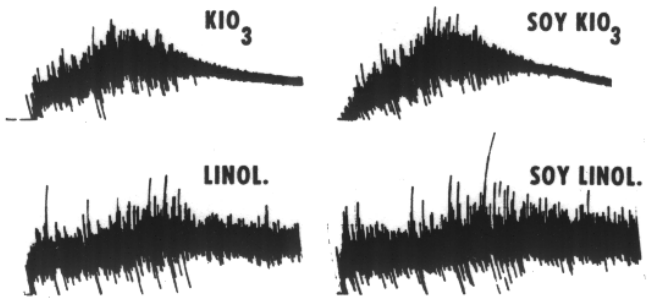



Fig. 4. Mixograms showing the effects of potassium iodate, enzyme-active soy flour plus potassium iodate, linoleic acid, and soy plus linoleic acid on the mixing stability of defatted flour. (Hoseney et al, 1980).

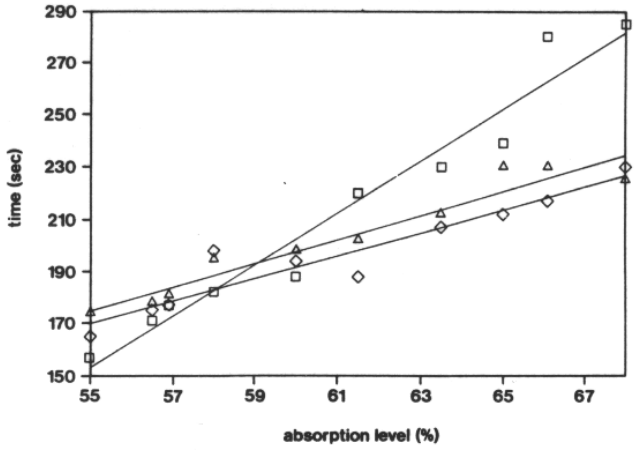



Fig. 5. Effect of powdered (◊)and presoaked (Δ) high molecular weight rye water-soluble pentosans on mixogram peak height of wheat flour (□) at different absorption levels. (Vanhamel et al 1993).

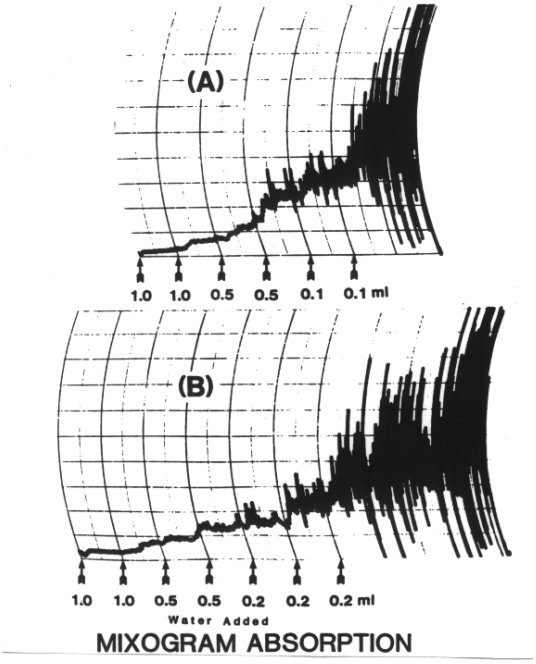



Fig. 6. Typical mixograms for pasta doughs from (A) semolina and (B) farina when using the water-injection technique without NaCl. (Oh et al. 1986).

# TABLE 1

## Effect of Apple Fiber and Cellulose on Mixogram Properties

| Fiber Source | Conc. (%) | Peak Time (min) | Water Abs (%) | Peak Height (cm) | Tolerance |
|---|---|---|---|---|---|
| Control | - | 3.60 ± 0.04 | 66.5 | 7.0 ± 0.0 | 0.88 |
| Apple | 2 | 3.75 ± 0.04 | 67.5 | 7.3 ± 0.1 | 0.89 |
| Apple | 4 | 3.75 ± 0.11 | 68.5 | 7.2 ± 0.1 | 0.90 |
| Apple | 6 | 3.75 ± 0.00 | 69.5 | 6.5 ± 0.0 | 0.90 |
| Apple | 8 | 3.75 ± 0.11 | 71.0 | 6.8 ± 0.4 | 0.89 |
| Apple | 10 | 3.85 ± 0.04 | 72.5 | 6.2 ± 0.1 | 0.90 |
| Cellulose | 2 | 3.70 ± 0.04 | 66.5 | 7.1 ± 0.5 | 0.85 |
| Cellulose | 4 | 4.20 ± 0.07 | 67.0 | 6.6 ± 0.1 | 0.88 |
| Cellulose | 6 | 4.20 ± 0.27 | 67.5 | 6.4 ± 0.1 | 0.91 |
| Cellulose | 8 | 4.10 ± 0.04 | 68.5 | 6.1 ± 0.1 | 0.92 |
| Cellulose | 10 | 4.70 ± 0.00 | 69.5 | 5.6 ± 0.0 | 0.95 |

Adapted from Chen et al (1988), by permission.

# Chapter 13
# A RAPID CHECK FOR VITAL GLUTEN QUALITY

K. J. Neufeld and C. E. Walker

Dept. of Grain Science and Industry, Kansas State University, Manhattan, KS, USA

Commercial wheat gluten, or *vital gluten*, is protein prepared from wheat flour, usually by washing the starch from a flour-water dough. It is commonly used to either strengthen a weak flour or to improve loaf volume when fiber or other components such as raisins are added (Gorton 1985). The amount added ranges from 2% up to 25%, flour weight basis. The bake test is commonly used to monitor gluten quality (Int. Wheat Gluten Assoc. 1989), but it takes too long for use during production. A rapid method that is relatively simple yet sensitive to product variations is needed and was developed at Kansas State University. The resulting procedure uses the Mixograph and a model dough system to monitor vital gluten quality. (For additional details see Neufeld and Walker 1990).

To validate the test, twenty commercial gluten samples were obtained from Europe, Australia, and North America. Protein contents ranged from 71.7 - 79.0% (db), moisture contents 2.9 - 7.9%, and average particle size 6.2 - 15.6μ (Fisher Sub-Sieve Sizer, Model 95, Fisher Scientific Co.). In addition, samples of a commercial vital gluten were heat treated for various times (2.5 - 10hr) at 110□C. to simulate over-drying.

A commercial wheat starch (moisture 10.7 %, protein 0.6%) was obtained. Hydroxypropyl methylcellulose (HPMC), Methocel K4M Premium (Dow Chemical Co.), served as a replacement for the water-solubles. Reagent-grade potassium iodate was used as an oxidant.

A model-dough system formula was balanced to yield a constant 15.0% protein (14% mb) "flour" for each gluten tested (Table 1). A pup-loaf procedure was developed based on the model-dough system. A scoring method that used pup-loaf percent of daily standard specific volume (PUP%DSSV) was calculated by dividing the specific volume (volume/ weight) of the test loaves by the specific volume of the daily control, the laboratory standard bread flour. The addition of HPMC and 0.5% $KIO_3$ was necessary to produce acceptably appearing mixograms with mixing times under 8 min, as well as acceptable bread loaves.

Increased heating time resulted in mixograms with noticeably increased mixing times (Fig. 1). Mixing properties also varied among the commercial glutens (Fig. 2). Samples 'A' and 'B' produced acceptable loaves, 'C' did not.

Those mixogram variables chosen by multiple regression as most related to pup-loaf bake score were midline peak time (PT), peak height (PH), and descending slope (DS). Linear regression using these three items yielded an $r^2$ value of 0.79, but second order regression analysis, using linear, quadratic, and across all products, yielded an $r^2$ value of 0.98. Predicted loaf volumes were calculated with the following second order multiple regression equation: $PUP\%DSSV = -90.42 + 21.77(PT) + 5.10PH) + 5.22(DS) - 0.54(PT^2) - 0.04(PH^2) - 0.95(DS^2) - 0.29(PT)(PH) + 0.33(PT)(DS) - 0.24(PH)(DS)$.

**REFERENCES**

Gorton, L. 1985. Structure and tolerance: A look at gluten's functionality. Bakers Digest 59(1):6.

International Wheat Gluten Association. 1989. Test Bake Methods. International Wheat Gluten Association, Prairie Village, KS

Neufeld, K. and Walker, C. E. 1990. Evaluation of commercial wheat gluten using the Mixograph. Cereal Foods World 35(7):667-669.

## TABLE 1

### "Flour" Formula for the Model System (10g Mixograph)

| Component | Dry Basis (%) | Solids Wt. (g) |
|---|---|---|
| Protein (gluten) | 15.0 | 1.29 |
| HPMC (solubles replacer) | 0.3 | 0.03 |
| Starch & non-gluten protein | 84.7 | 7.28 |
| TOTAL SOLIDS | 100.0 | 8.60 |
| Water (with corrected absorption) | | 1.40 |
| TOTAL "FLOUR" WEIGHT | | 10.00 |

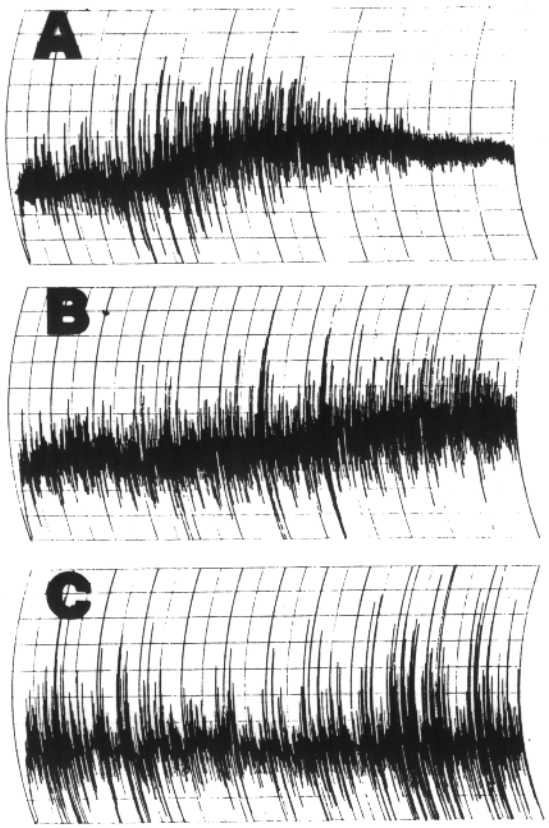



Fig. 1 Effect of heat treatment on gluten. (A) untreated gluten at 57% absorption, (B) heat-treated gluten (2.5hr at 110°C) at 54% absorption, (C) heat treated gluten (10hrs at 110°C) at 54% absorption.

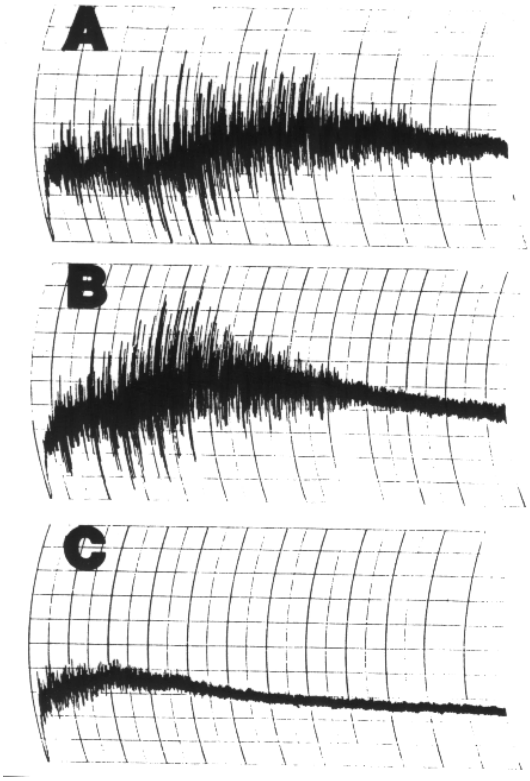



Fig. 2 Typical differences among commercial glutens. (A) untreated gluten at 57% absorption, (B) gluten (75% protein, 10.1μ average particle size) at 61% absorption, (C) gluten (72.9% protein, 6.2μ average particle size) at 57% absorption.

# Chapter 14
# MIXOGRAPH APPLICATION FOR THE EVALUATION OF WHEAT USED FOR PASTA

W. J. Pitz

North Dakota State University, Department of Cereal Science and Technology, Fargo, ND, USA

The relationship between strong gluten and improved cooking performance and cooked quality of spaghetti has been recognized for many years. Plans to develop strong gluten durum cultivars through plant breeding have existed in the United States since the 1950's (Sibbitt and Harris 1957). At that time, techniques available to evaluate gluten properties were gluten "washing", chemical treatment, and recording dough mixers. The Mixograph was included among the dough mixing instruments in use at that time (Sibbitt et al. 1956). Sibbitt and Harris (1957) showed excellent agreement among the Mixograph, Farinograph, and extensograph when ranking seven durum wheat cultivars in order of decreasing gluten strength.

The mixing action of the Mixograph, with a pull-fold-repull type of mixing action, is much more severe than that of the Farinograph (Vasiljevic and Banasik 1980). Nevertheless, Mixograph and Farinograph mixing curves show great similarity with good gluten strength ranking agreement for cultivars (Sibbitt and Harris 1957, Bendelow 1967). The rate of dough development (peak time), resistance of the dough to mixing (band width), and tolerance of the dough to extended mixing (range of stability) all relate to gluten characteristics. As is the case with bread wheat, longer peak time, greater band width, and longer range stability are characteristic of strong gluten. These parameters can be measured and expressed numerically, but in actual practice visual assessment of the curves is adequate for most applications (Bendelow 1967, Quick and Donnelly 1980, Vasiljevic and Banasik 1980).

It was not until the mid to late 1960's that the Mixograph began to find widespread use for the evaluation of macaroni doughs. By then, research reports relating gluten strength to improved spaghetti quality had begun to appear in the literature, and breeding programs to develop strong gluten cultivars were underway (Sheu et al. 1967, Matsuo and Irvine 1970). Bendelow (1967) reported on the application of a micromixer in his durum screening program. The instrument he used was the newly designed electronic dough mixer developed by the Ottawa Research Station (Voisey et al. 1966). It employed an improved mechanism for measuring and recording resistance of the dough to mixing, and required only 10g of sample, making it particularly suited for screening early-generation plant breeder material. The durum quality screening laboratory in the Department of Cereal Science and Food Technology at North Dakota State University later adopted the 10g Mixograph unit described by Finney and Shogren (Finney and Shogren 1972).

Several studies have recently reported on the Mixograph's predictive capability at estimating spaghetti cooking performance and cooked quality. Dexter and others evaluated an SDS-sedimentation test for estimating gluten strength and compared it to the microMixograph (Dexter et al. 1980). Both tests exhibited highly significant correlations with gluten breaking strength, the former accounting for 56.8% and the latter 51.7% of the variability. Gluten breaking strength in turn correlated highly with spaghetti cooking quality and overcooking quality. In a similar study, Dick and Quick (1983) showed that the microMixograph accounted for 36.5% of the variation in spaghetti firmness, and when considered together with total wheat protein, the two accounted for 64.9% of the variation. In studies to incorporate strong gluten into durum cultivars by chromosome substitution and addition, Joppa and others found the Mixograph useful in identifying lines with superior gluten strength and spaghetti-making quality (Joppa et al. 1975, Josephides et al. 1987; Joppa et al. 1983). Both the Mixograph and SDS-sedimentation test reliably identify strong gluten cultivars because neither are markedly affected by environment-induced changes in protein content (Quick and Donnelly 1980, Matsuo et al. 1982).

The procedure employed by the Department of Cereal Science and Food Technology at North Dakota State University uses 10g of flour, 14% moisture basis, mixed with a fixed 5.8 ml at 25° C water for 8 minutes, with the spring setting at 8. The evaluation process compares the test sample to reference or standard mixograms (Fig. 1) and assigns a score according to its closest reference match. [It was noted that the mixogram times to peak, band widths, and peak heights generally all increase with reference mixogram number. Therefore, it is possible to calculate a score via multiple regression analysis - Ed.] The reference mixograms were selected to show a wide range in gluten strength and mixing patterns. Weak gluten durum cultivars such as Rugby and Ward typically produce mixograms that score 1 or 2 and strong gluten cultivars such as Monroe and Renville typically produce mixograms that score 7 or 8.

The Mixograph also finds limited application in the evaluation of flour used in the making of oriental noodles. In addition to using it to evaluate rheological properties of dough, it has been used experimentally as a means to determine optimum water absorption of flour (Oh et al. 1986, Rho et al. 1988). It is expected that the Mixograph will remain a useful tool in the evaluation of wheat for pasta products for years to come.

**REFERENCES**

Bendelow, V. M. 1967. Early-generation screening for gluten strength in durum wheat breeding. Cereal Sci. Today 12(8):336-337.

Dexter, J. E., Matsuo, R. R., Kosmolsk, F. G., Leisle, D., and Marchylo, B. A. 1980. The suitability of the SDS-

sedimentation test for assessing gluten strength in durum wheat. Can. J. Plant Sci. 60:25-29.
Dick, J. W. and Quick, J. S. 1983. A modified screening test for rapid estimation of gluten strength in early-generation durum wheat breeding lines. Cereal Chem. 60(4):315-318.
Finney, K. F. and Shogren, M. D. 1972. A ten-gram Mixograph for determining and predicting functional properties of wheat flours. Bakers Digest 46(2):32-35, 38-42, 77.
Joppa, L. R., Bietz, J. A., and McDonald, C. 1975. Development and characteristics of a disomic-1D addition line of durum wheat. Can. J. Genet Cytol. 17:355-363.
Joppa, L. R., Josephides, C. M., and Youngs, V. L. 1983. Chromosomal location of genes affecting quality in durum wheat. Pages 297-301 in: Proc. 6th Int. Wheat Genet Symp.: Kyoto, Japan.
Josephides, C. M., Joppa, L. R., and Youngs, V. L. 1987. Effect of chromosome 1B on gluten strength and other characteristics of durum wheat. Crop Sci. 27(2):212-216.
Matsuo, R. R., Dexter, J. E., Kosmolak, F. G., and Leisle, D. 1982. Statistical evaluation of tests for assessing spaghetti-making quality of durum wheat. Cereal Chem. 59(3):222-228.
Matsuo, R. R. and Irvine, G. N. 1970. Effect of gluten on the cooking quality of spaghetti. Cereal Chem. 47(2):173-180.
Oh, N. H., Seib, P. A., Finney, K. F., and Pomeranz, Y. 1986. Noodles. V. Determination of optimum water absorption of flour to prepare oriental noodles. Cereal Chem. 63(2):93-96.
Quick, J. S. and Donnelly, B. J. 1980. A rapid test for estimating durum wheat gluten quality. Crop Sci. 20:816-818.
Rho, K. L., Seib, P. A., Chung, O. K., and Deyoe, C. W. 1988. Noodles. VII. Investigating the surface firmness of cooked oriental dry noodles made from hard wheat flours. Cereal Chem. 65(4):320-326.
Sheu, R. Y., Medcalf, D. G., Gilles, K. A., and Sibbitt, L. D. 1967. Effect of biochemical constituents on macaroni quality. I. Differences between hard red spring and durum wheats. J. Sci. Food Agr. 18:237-239.
Sibbitt, L. D. and Harris, R. H. 1957. New quality data on Dakota durums. North Dakota Agr. Expt. Sta., Bimon. Bull. XIX (4):115-118.
Sibbitt, L. D., Scott, G. M., and Harris, R. H. 1956. Milling and macaroni-making quality of four new durums. North Dakota Agr. Expt. Sta., Bimon. Bull. XVIII(3):88-92.
Vasiljevic, S. and Banasik, O. J. 1980. Quality testing methods for durum wheat and its products. Dept of Cereal Chem. and Techn., North Dakota State Univ., Fargo, ND pg 86-91.
Voisey, P. W., Miller, H., and Kloek, M. 1966. An electronic recording dough mixer 1. Cereal Chem. 43:408.

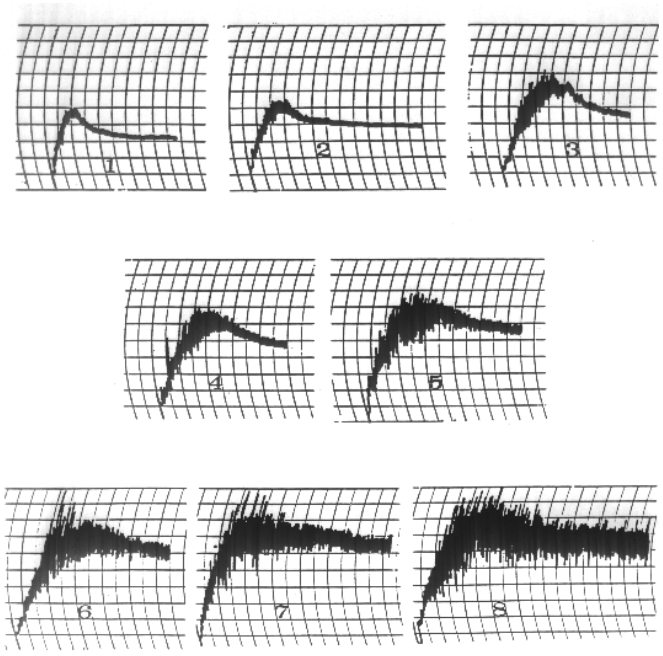



Fig. 1 Reference mixograms for durum wheat.

# Chapter 15
# ASSESSMENT OF DRYING DAMAGE TO HARD WHEATS

K. R. Preston

Canadian Grain Commission, Winnipeg, MB, Canada.

This paper describes a Mixograph procedure for assessing heat damage caused by drying hard wheat with hot air. The procedure was developed by Preston and co-workers (1989) for assessing such damage in Canadian hard red spring wheats but is applicable to any bread wheat. Heat damage can result in reduced baking quality, changes in physical dough properties, and decreased seed viability without visually altering the wheat kernel (Geddes 1929, Becker and Sallans 1956, Watson 1970, Booth et al. 1980, Ghaly and Sutherland 1984). Many tests have been developed to evaluate heat damage, but the most relevant test would measure the baking quality as it relates to the end product (Harrison et al. 1969, McDermott 1971, Every 1987, Lupano an Anon 1988). Applying excessive heat can affect any wheat such that its mixogram curve will show notable changes.

It is necessary to have a control wheat (not heat dried) in order to make comparisons of "before" and "after" heating. The control wheat as well as the heated are milled on a modified Allis Laboratory mill using a short mill flow consisting of three break passes and a reduction pass (Black et al. 1980). The straight grade flour yield would be between 60-65% extraction. Other milling procedures, including the 'long' normal Allis, Buhler, and Brabender Jr. Quadramat could also be used to produce satisfactory results. Flour, 35g or 10g (14% moisture basis) depending on size of Mixograph used, is added to the mixing bowl and an appropriate amount of water is added. Absorption water is 66% for both the control and heated wheats, however in some cases, increasing water absorption by 1-3% can give better discrimination. Mixograms are run for 6 min.

Figure 1 shows examples of "before" and "after" mixograms. They are rated as (A) satisfactory; (B) satisfactory but slightly changed; (C) seriously reduced; and (D) damaged. The most notable changes in curve characteristics are a lowering of the overall curve and an increase in the time to peak. Peak time can seem to be infinite, when damage is great. The absence of a control wheat reduces the ability to determine the degree of damage except when the levels of (C) and (D) are reached.

Additional changes noted on wheat dried at excessive temperatures include decreases in the ratio of wet gluten to protein, Farinograph absorption and dough development time, and extensigraph length (extensibility). The effects to extensibility are most pronounced for the damaged (D) category. Test weight and amylograph peak viscosity values increased in the "after" samples. Other work noted that the higher the wheat's moisture content, the lower the maximum drying temperature (Finney et al 1962). Sensitivity to heat damage increases with increasing moisture content which lowers the maximum "safe" drying temperature.

Blending studies show that the addition of commercially heat damaged wheat to undamaged wheat has significant detrimental effects upon quality characteristics at levels as low as 20%. Osborne fractionation and gel filtration studies indicated that the proportion of the insoluble glutenin protein fraction was most affected by heat damage (Booth et al 1980, Lupano and Anon 1987).

**REFERENCES**

Becker, H. A. and Sallans, H. R. 1965. A study of the relation between time, temperature, moisture content, and loaf volume by the bromated formula in the heat treatment of wheat and flour. Cereal Chem. 33(4):256-265.

Black, H. C., Hsieh, F. H., Tipples, K. H., and Irvine, G. N. 1980. The GRL sifter for laboratory flour milling. Cereal Foods World 25(12):757-760.

Booth, M. R., Bottomley, R. C., Ellis, J. R. S, Malloch, G., Scholfield, J. D., and Timms, M. F. 1980. The effect of heat on gluten-physico-chemical properties and baking quality. Ann. Technol. Agric. 29:399.

Every, D. 1987. A simple, four minute, protein-solubility test for heat damage in wheat. J. Cereal Sci. 6(3):255.

Finney, K. F., Shogren, M. D., Hoseney, R. C., Bolte, L. C., and Heyne, E. G. 1962. Chemical, physical, and baking properties of preripe wheat dried and varying temperatures. Agronomy J. 54:244-247.

Geddes, W. F. 1929. Chemical and physico-chemical changes induced in wheat and wheat products by elevated temperatures I. Can. J. Res. 1:528.

Ghaly, T. F. and Sutherland, J. W. 1984. Heat damage to grain and seeds. J. Agr. Eng. Res. 30:337.

Harrison, K. R., Doarks, P. F., and Greer, E. N. 1969. Detection of heat damage in dried wheat. Milling 151:37.

Lupano, C. E. and Anon, M. C. 1988. A simple and rapid test for drying damage in wheat. Cereal Chem. 65(1):49-51.

McDermott, E. E. 1971. The turbidity test as a measure of thermal denaturation of proteins in wheat. J. Sci. Food Agric. 22:69.

Preston, K. R., Morgan, B. C., Kilborn, R. H., and Tipples, K. H. 1989. Assessment of heat damage in Canadian hard red spring wheats. Canadian Inst. Food Sci. Technol. J. 22(1):63-69.

Watson, E. L. 1970. Effect of heat treatment upon the germination of wheat. Can. J. Plant Sci. 50:107.

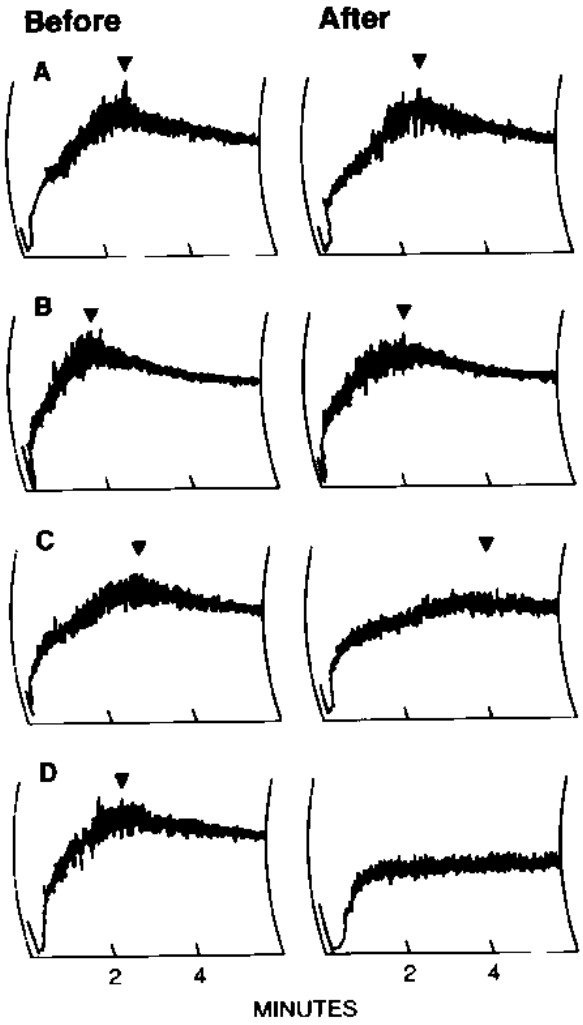



Fig. 1 Mixograms of four wheats before and after hot air drying. A – satisfactory, B – satisfactory, but slightly changed, C – seriously reduced, and D – damaged.

# Chapter 16
# MIXOGRAPH USE AT THE U.S. WESTERN WHEAT QUALITY LABORATORY

G. L. Rubenthaler

U.S.D.A., Ret., Clarkston, WA, USA.

The Mixograph has been a valuable tool to evaluate experimental germplasm from the wheat breeding programs in the western states for the USDA, ARS, Western Wheat Quality development program. The region is unique among the major wheat producing areas in that all wheat classes are grown due to the wide variation in climates, soils, and farming practices. The major wheat class is hard red and about ninety percent of the production are from winter varieties, but all classes have companion spring varieties. California and the Southwest production is principally marketed as hard red spring varieties, although fall planted, and production of hard white occurs throughout the region.

The laboratory evaluates the end use quality of 6,000 to 10,000 experimental lines each year, with emphasis on the efficiency of early generation (F3 & F4) testing. One of the primary tests conducted is a mixogram. Wheat breeders cross hard wheats with soft wheats, spring wheats with winter wheats, and use exotic wheats from all over the world. The progenies often have dough curves and other properties which do not conform to traditional market class characteristics so the Mixograph is very useful in identifying these atypical properties.

Samples are run using a 10g Mixograph and "optimum absorption" is determined (discussed elsewhere). Most mixograms are run for either 7 or 8 minutes, which is sufficient for most flours to give a full picture of their mixing time and to show the degree of mixing tolerance, or dough stability with continued mixing beyond the optimum point (peak). Mixograms are run in a temperature-controlled laboratory (25° C) where the flour, water and instrument bowl are held at that constant temperature. Mixograms are visually evaluated for mixing properties, including water absorption, mixing time, dough mixing tolerance, and general gluten strength, which are factors related to the flour's functionality.

The Mixograph was originally developed as a test to characterize hard wheats for bread products where water absorption, mixing time, and strong gluten development (curve height and width) can be correlated to bread making potential. However, the information obtained from the mixing curve is also of significant value in characterizing soft wheats. Traditionally, some desirable properties of soft wheat flours are low water absorption and quick uptake of that water at the dough makeup stage. Several of the major soft wheat products such as cakes and cookies are mixed only sufficiently to uniformly incorporate all the formula ingredients and to keep gluten protein development to a minimum.

Other major uses for soft white wheat include Middle Eastern flatbreads, various steamed breads, and an assortment of oriental noodles. Some flour properties best suited to these products are low to intermediate absorption, short mixing times, and low to intermediate gluten strength, characteristics shown in the mixogram. Again, water uptake rate and gluten development can be measured by the Mixograph.

In 1970, an effort was done to semi-quantitate Mixograph curves by developing a chart containing a set of 24 mixograms which covered the range of the very weakest soft wheats (clubs) to the strongest. Consideration was also given to show the effect protein content had on mixing characteristic within a variety. It was found that as protein decreased, an apparent decrease in mixing tolerance was also occurred. Due to this relationship, it was inappropriate to make a final mixogram evaluation without full consideration being given to the flour protein content. The chart was used as a means to communicate the dough mixing properties in reports to the wheat breeders as a replacement for bulky copies or photographs of mixograms. The chart was referred to as "Mixograph Reference Chart" and had been widely used and accepted (Fig. 1)

To illustrate the protein effect, compare #1 low (L) with #1 medium (M) and #1 high (H), which are typical mixograms for the traditional club wheat sub-class, at 6%, 9%, and 12% protein, respectively. Similarly, 2L, 2M, and 2H are typical for most of the soft white winter wheat varieties of the region, over the same protein range.

Other soft white winter wheats may be intermediate to the 2 and 3 levels. These common soft white and club, winter, or spring selections should be low in protein content. Their mixograms should reflect the following properties: low water absorption, short mixing requirement, and no appreciable development with continued mixing, i.e. the mixing curve area should be low, showing weak and very mellow gluten strength. Club wheat flour should have lower water absorption and weaker mixing properties and gluten strength than the soft common wheat flours. Generally, the 3-8's are curves which fit the hard red wheats with most in the 3-5 range. The 6-8's are extremely long and/or strong but are found among wheats in breeding programs. Little change in dough mixing properties can be observed below 7% or above 13% protein.

In a wheat breeding program, particularly at the early generation stage, the need for a small scale flour milling step proved to be a disadvantage. However, it was demonstrated that a simple sifted whole wheat meal preparation could provide a sample that gave near identical mixograms to those of milled flours, but consideration was given to the system for interpreting optimum absorption and protein influence (Bruinsma et al. 1978). The technique is being used by one or

more of the major flour milling companies to screen wheat lots for purchase. The laboratory has made little use of the method because we also needed flour milling properties on the progenies tested.

With the development of the new 2 g Mixograph, the "whole wheat meal" method may lend itself ideally to the testing of earlier generation single plant selections. Similarly, with the advent of digital output from the Mixograph, it should be readily possible to model a computerized correction to synthesize a curve to some constant protein level, so comparisons could be made directly. Further, with the developments in digital output and computer programs, the potential to extract more information from the Mixograph is on the immediate horizon.

Using an electronically recorded Mixograph (ERM), Rubenthaler and King (1978) showed highly significant correlations with nine ERM values derived from the total energy (mixogram) curve and various functional baking properties of both hard and soft wheats. They concluded that additional computer models were necessary to compensate for the influence of protein (both in the dough mixing characteristics and in the actual baking performance). They visualized the need to have a shifting series of models, the choice of which would be determined by the wheat protein content.

**REFERENCES**

Bruinsma, B. L., Anderson, P. D., and Rubenthaler, G. L. 1978. Rapid method to determine the quality of wheat with the Mixograph. Cereal Chem. 55(5):732-735.

Rubenthaler, G. L. and King, G. E. 1986. Computer Characterization of mixograms and their relationship to baking performance. Pages 131-168 in: Fundamentals of Dough Rheology. H. Farad and J. Faubion, eds. Am. Assoc of Cereal Chem.: St. Paul, MN.

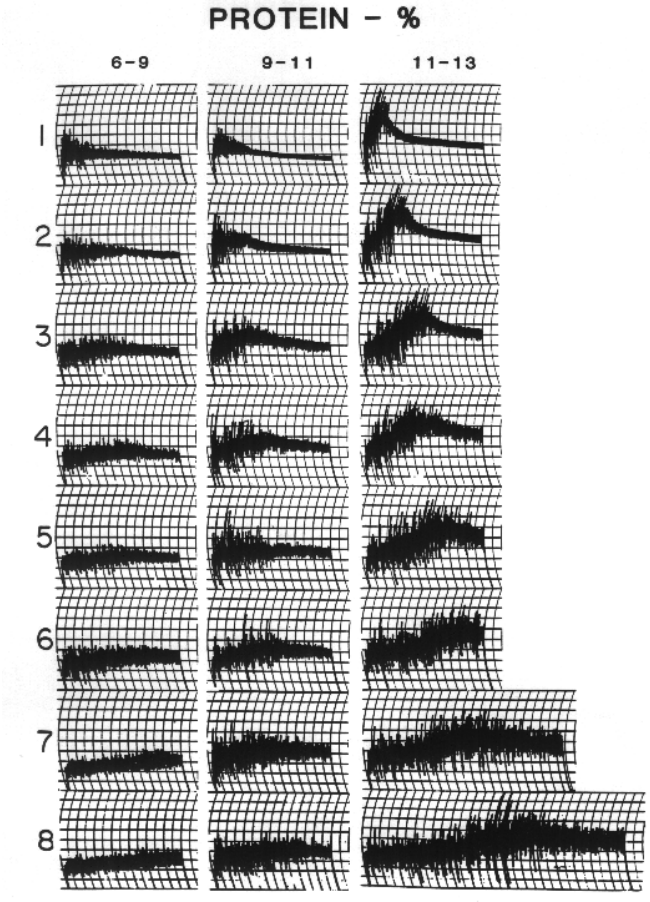



Fig. 1 The "Mixograph Reference Chart" contains a set of 24 mixograms which covers the range of the very weakest soft wheats (clubs) to the strongest. Consideration was also given to show the effect protein content had on mixing characteristic within a variety.

# Chapter 17
# USE OF THE MIXOGRAM FOR BETTER MANAGEMENT OF WHEAT SELECTION DECISIONS

R. M. Pudden

Department of Grain Science and Industry, Ret., Kansas State University, Manhattan, KS, USA.

Commercial mills often need a quick test for probable mixing quality. As a preliminary screening test, small samples representing available commercial lots of wheat may be evaluated by a whole meal Mixograph procedure. Samples are mill cleaned as for normal laboratory tests relating to physical and chemical properties. A portion of ca. 80 grams is then ground on a Udy grinder or equivalent for NIR or comparable testing, and the remainder is set aside for testing with the 35 gram Mixograph.

Since most samples are received in a rather narrow moisture range, a set absorption of 65% is used. Enough of the sample remains to repeat the process with an adjusted absorption, if the graphs moisture peak does not fill in the central 60% of the graph 0-100 scale.

The Mixograph data is evaluated immediately after running. Results obtained with the bowl oscillating in response to mix torque, and with the damper spring set at #12, will be evaluated as follows:

**X** = Measure mixing time to the optimum (peak) of curve in cm, on the standard chart paper. (1 min = 1.91 cm).

**Y =** Measure width at the peak in cm. (1% = 0.115 cm).

**Z =** Measure width at three cm (1.57 min) after peak, in cm (1% = 0.115 cm).

Formula as follows:

3 **X**, + 2 **Y**, + 4 **Z** = Value Number

Value numbers 26 and above are classified as A, Numbers 18-25 as B, 17 and below as C.

These results are only a very quick way to provide a number and a recommendation as to suitability for blending purposes for white panbread. The primary value of this system is when it is used along with the other ancillary tests that establish important information at the same time. In many instances, speed is of the essence in purchasing decisions. For example, if ten samples are tendered, one laboratory technician can easily analyze them between 8:00 and 12:00 noon. This can provide the pertinent information needed by the purchasing agent for an intelligent decision in relation to the wheat's relative value, and subsequent bid offers.

# Chapter 18
# Quality Screening Using the Mixograph in Canada

O. M. Lukow

Agriculture Canada Winnipeg Research Station, Winnipeg, MB, Canada.

Since its inception in 1960, the Cereal Quality Laboratory located at the Agriculture Canada Winnipeg Research Station has provided a key service to public and private plant breeders developing varieties for growth in western Canada. The laboratory currently analyzes over 10,000 wheat samples per year, the majority of which are bread wheats. Samples from any of the wheat classes commercially grown in the region may be submitted for analysis. Mixograph analysis of early generation lines has become an integral component of quality testing, particularly for those wheat classes destined for bread products (Lukow 1991). These classes include: Canada Western Red Spring, Canada Prairie Spring, Canada Western Red Winter and Canada Western Extra Strong. Typical 10g mixograms as generated on a strip-chart recorder (pre-computer analysis) are shown in Fig. 1. The curve profiles are characteristic of weak-, strong- and over strong dough mixing flours that are commonly assessed in the Cereal Quality Laboratory. The profiles provide an assessment of the rheological properties of flour and an estimation of breadmaking quality.

The value of the Mixograph in assessing the dough mixing characteristics of early generation lines was recognized when two 10g and one 5g Mixographs were specifically developed by Voisey et al. (1966 a, b) for the Cereal Quality Laboratory. The torque was recorded electronically thereby making the Mixographs more sensitive and precise than previous commercially available instruments. The 10g Mixographs have been used for the quality screening of breeders' lines whereas the 5g Mixograph has been used exclusively for research purposes. Both 10g Mixographs maintain the dough at a constant temperature, one through a jacketed bowl and water bath system and the other through a heated cabinet (Fig. 2). From 1966 to 1986, the mixogram development time, that is, the time required for the curve to reach maximum height, was the only curve parameter reported to the breeders. The time required for manual analysis prevented more extensive interpretation of the curves. In 1987, the Mixographs were interfaced with a micro-computer system to allow computer-based data acquisition and analysis (Pon et al. 1989, Buckley et al. 1990). The multilevel system uses an IBM PC computer, with a hardware/software interface for four mixers, to acquire and preprocess data. The data are electronically transferred to another IBM PC computer for analysis. This endeavor has effectively reduced the labor, time, and potential for error associated with manual analysis and data capture with a large number of samples. In addition, computerization has increased the amount of information available from the mixograms. For a typical curve, eight parameters are calculated and transmitted to breeders. These include: PHG, peak height of mean curve; MDT, mixing development time, ETP, energy to peak; FMS, first minute slope; PBW, peak band width; SAP, slope after peak, TEG, total energy; BWE, band width energy. An example of a computerized mixogram is given in Fig. 3. The processed data is uploaded directly into computerized reports, which are electronically transmitted to client breeders.

A typical Mixograph analysis involved dispensing 10g Brabender milled flour into the Mixograph bowl, adding 6.2mL water and programming the run for 6 min. at 30°C. For most samples, the time allotted is adequate for complete dough development and breakdown curve to be generated. No adjustment is made for water absorption. More than 50 flour samples can be run per Mixograph per day by one operator.

Quality screening in Canadian breeding programs typically begins with seed from fourth generation ($F_4$) plants when heritable quality traits such as dough mixing strength are relatively stable. The limited amount of seed available (ca. 60-100g) precludes the use of large-scale technological tests. Wheat samples received at the Cereal Quality Laboratory are processed firstly for protein content and kernel hardness by whole grain near infrared analysis and culled. Lines are then Brabender milled and are culled on the basis of flour yield. Finally, the remaining lines are sent for Mixograph analysis to determine the basic dough rheological properties. It is at this point in the testing protocol that the Mixograph has become extremely useful as a key instrument.

Through the Mixograph determination of thousands of samples, it has become apparent by regression analysis that mixogram peak height rather than development time is the most important parameter in predicting breadmaking quality. Mixogram peak height is a function of three important quality attributes: protein content, water absorption, and dough strength. When breeders receive Mixograph data and need to cull lines with unsuitable dough properties they give more weight to this characteristic. Recent research has examined the possibility of using ground whole meal in lieu of flour for Mixograph analysis. Preliminary positive results indicate that this may be an efficient method to deal with increasing numbers of breeders' lines in the future.

## REFERENCES

Buckley, D. J., Lukow, O. M., Lalonde, J. L. M., and Woods, S. M. 1990. A multilevel computer system for dough quality analysis and report distribution. Cereal Foods World. 35:472-478.

Lukow, O. M. 1991. Screening of bread wheats for milling and baking quality - A Canadian perspective. Cereal Foods World. 36:497-501.

Pon, C. R., Lukow, O. M., and Buckley, D. J. 1989. A multichannel, computer-based system for analyzing dough rheology. J. Texture Studies. 19:343-360.

Voisey, P. W., Miller, H., and Kloek, M. B. 1966a. An electronic recording dough mixer. I. The apparatus. Cereal Chem. 43:408-419.
Voisey, P. W., Miller, H., and Kloek, M. B. 1966b. An electronic dough mixer. II. An experimental evaluation. Cereal Chem. 43:420-432.

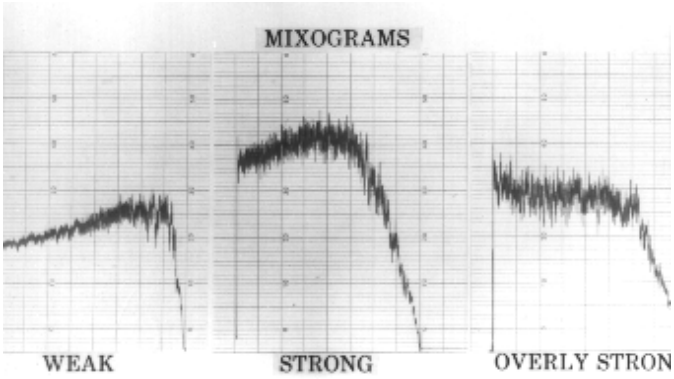



Fig. 1 Mixograms of three commonly assessed flour types at the Cereal Quality Laboratory.

Fig. 2 The 10g Mixographs with jacketed bowl temperature regulation (left) and heated cabinet (right).

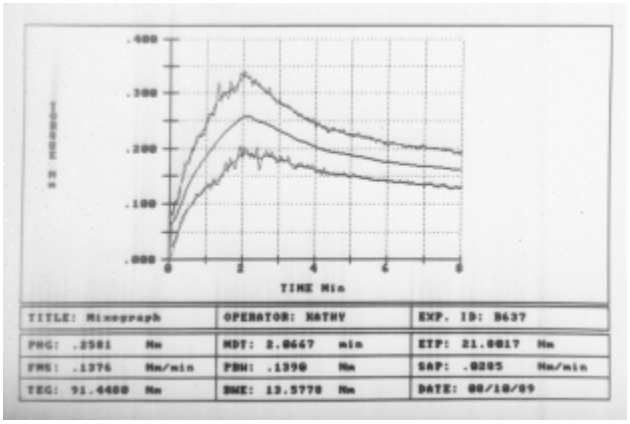



Fig. 3 Computerized mixogram of a bread wheat flour.

# Chapter 19
# THE MIXOGRAPH IN EUROPE

D. Weipert

Federal Center for Cereal, Potato, and Lipid Research, Detmold, Germany

While Swanson and Working introduced the Mixograph in America, another recording mixer, the Farinograph was already widely accepted not only in Germany, but elsewhere in Europe and world wide (Swanson and Working 1933, Brabender 1933, 1934). One of the advantages, which made the Farinograph useful and desirable, was the fact that it was a part of a system (Farinograph, extensograph, amylograph) for extensively describing wheat quality (Mueller 1936). It has met the needs of wheat breeders and processors for decades and is still doing so today with unchanged acceptance and reliability. It seems that its type of mixing and kneading is suitable for the European wheats which have somewhat different dough properties and also vary in water absorption capacity as compared with wheats grown on the North American continent. The European, and particularly the German, quality scheme is built on characterizing the rheological properties of dough (consistency and elasticity) which require not only the Farinograph but even more so the extensograph. The advantage of the Mixograph, its ability to use small samples, has been compensated for by the development of equally small Farinograph mixers which use 10 or 50g flour. This, and their difference in mixing action, explains why the Mixograph has not generally found wide use among European wheat breeders and processors.

## MIXOGRAPH AND FARINOGRAPH MIXERS

An obstacle to the Mixograph's introduction and establishment in Europe is that the results from farinograms and mixograms seem to be different, in spite of the fact that both instruments are recording the dough's behavior during mechanical mixing, development, and structure breaking down. While the Farinograph blades press, shear, and stretch the dough, though not strongly destructive; the Mixograph pins fold, twist, pull and stretch the dough much more intensively, and are capable of destroying the dough's structure in a much shorter mixing time than the Farinograph. This is probably the reason for the different behavior in doughs from high and low protein flours. A protein rich flour will generally develop faster in the Mixograph then in the Farinograph, while the protein poor flour provides a short Farinograph peak development time. With some exceptions, the same is valid for flours with strong and weak glutens. But, a long mixing time and high dough strength is, for many processors, a desired flour quality.

The different dough mixing principals provided by the Mixograph, Farinograph and resistograph were compared by testing the doughs after being mixed to a certain state of development and after certain mixing times, and at different mixing speeds and water additions (Weipert 1987, Weipert 1989). The readings for consistency and for dough properties from the stress-strain curves recorded in a rotational viscometer have established a tendency of mixing intensity and rheomalaxy ranking the Mixograph the highest and the Farinograph the lowest (Table 1). After mixing doughs from 3 strong and 3 weak varieties for 7 min, the Mixograph doughs had a lower viscosity (consistency) than Farinograph doughs, at the same water addition. After 20 min of mixing, Farinograph dough viscosities were as low as Mixograph dough viscosities after only 7 min mixing. After mixing to peak time, the Mixograph doughs had higher viscosity than the Farinograph doughs, proving again the more intensive action of the Mixograph in developing the dough (Weipert 1987). The more intensive mixing of the dough in a Mixograph was probably a major argument for accepting the Mixograph for strong wheat doughs in the USA (Hoseney and Finney 1974, Svenson 1984).

The work applied and total energy inputs when mixing dough in Farinograph and Mixograph can be compared by using a recording drive (Weipert 1989). By driving both the Farinograph and Mixograph mixers with an electronically controlled drive at different mixing speeds, and recording the torque in comparable physical units, it is possible to measure the applied work or energy input. Although the geometry and speed of the mixing actions in the two mixers are not completely describable, the energy input measurement allows the description of the energy input in N cm / dough from 10g flour. While increasing the mixing speed from 40 to 120 rpm in several steps (including those speeds used by Farinograph and Mixograph), increased torque values for the recorded mixing curves and decreased mixing times to peak were observed (Weipert 1989). Taking into consideration the torque values at peak and after 15 min, the corresponding mixing speeds, and the actual dough weights in the mixer, some remarkable differences were observed (Fig. 1). At low mixing speeds, higher torque values (thus higher work inputs) were observed for strong rather than weak flours on the Farinograph than on the Mixograph, both at peak and after 15 min of mixing. At high mixing speeds, the differences are smaller, but the higher torques were still preserved for the Farinograph doughs. The torques for the mixing curves after 15 min of mixing in both mixers are significantly lower than for the peaks. The energy input can be calculated from the mixing curves by considering the mixing time to a certain point, or by calculating the area under the mixing curve. A comparison of the Farinograph and Mixograph mixing modes should be done with the Farinograph at 63 rpm and the Mixograph 80 rpm to lessen the torque differences between the two mixers. Nevertheless, it will still be only an approximation unless the secondary planetary movement of the Mixograph pins can be exactly considered.

## SPECIFY BOWL SIZES

A paper was recently published by Mani and co-workers (1992) comparing the optimum elasticity state of wheat flour

doughs as prepared by different mixers. The dependence of the storage modulus (G′) upon the type of the mixer (including the Farinograph and the Mixograph) and the mixing time were discussed, concluding that the optimum mixing time is specific to flour, mixer, and to the type of bakery food the dough is destined for. The storage modulus for Mixograph doughs decreases with mixing time more obviously than those for Farinograph doughs, which is consistent with the earlier data (Weipert 1987).

**EXPERIENCE WITH THE MIXOGRAPH IN EUROPE**

There have been some attempts to use the Mixograph in Europe, mostly initiated by American scientists visiting in Europe or by those Europeans who have spent sufficient time in American laboratories to become acquainted with this instrument. Two advantages, a smaller sample and a shorter test time were cited as the reasons for recommending the use of the Mixograph method for evaluating bread wheat breeding, particularly for soft and durum wheats (Sauer 1976, Bourdet et al. 1976, Belderok 1977, Günzel 1982, Svenson 1984, Boggini and Nilsson 1976, Boggini et al. 1981, Pomeranz et al. 1983, Pomeranz et al. 1984). There are not many reports on testing European wheats with the Mixograph in the USA (Jeffers and Rubenthaler 1978, Pomeranz et al. 1984, Finney et al. 1977, Finney et al. 1985).

One of the first experiences the Europeans had with the Mixograph was that a quick and efficient test (about 50 samples a day) necessitated a constant water addition and a knowledge of the protein content of the flours. For the somewhat lower protein contents of European wheats (12.5% in grain and 10.5% in flour, or less) it was recommended to use a lower constant water addition corresponding to 55% instead of 60% absorption (Belderok 1977). A simple Brabender Junior Quadrumat mill was recommended for preparing the flour.

By examining the mixograms of European wheat, about five types were established between the low and the high quality range (Fig. 2). At the beginning of the seventies in Europe, and particularly in Germany, there were a number of wheat varieties with excellent yield and agronomic properties, but they processed poorly. Quick and reliable methods were required for the identification of unfavorable dough properties; soft, weak, slack, or sticky character. Some of these varieties had the rye genomes which were favorable for disease resistance but which caused gluten weakness. Besides the sensory test, the Farinograph, resistograph, and rheometer were suggested. Due to its quick test and small sample, the Mixograph was considered for scanning for unfavorable dough mixing properties (Belderok 1977, Sauer 1976). Such varieties would have a short peak time, virtually no mixing tolerance, and would correspond to type 1 in Figure 2 or to the left mixogram in Figure 3. In the other hand, a long peak time (over 5 min) and a long mixing tolerance is claimed to be detrimental to the mixing, fermenting and baking process as well (Sauer 1976).

The type 1 (Fig. 2) mixogram, farinogram, and extensogram illustrate a weak wheat, including the varieties with slack and sticky doughs which were "unbakable". From the weak mixogram, farinogram, and extensogram curves, the doughs of such wheat varieties are characterized by a completely destroyed structure and could be "poured in thin traces from the pins" after 8 min of mixing in the Mixograph (Sauer 1977). Type 5 (Fig. 2) represents a strong, high quality wheat giving a high baking score flour which can be used by itself or as an improver in a blend with a weaker wheat flour. Types 2-4 are of intermediate properties. The short, quick, and simple of mixograms, and identifying them with one of the 5 types of farinograms and extensograms without making further evaluation, could be a big help in screening for wheat quality during the early stages of breeding (Sauer 1977).

When evaluating mixograms, the peak time was taken as the significant characteristic by Sauer (1976). For the relationship between peak time and bake volume via a micro baking test, an unsatisfactory correlation coefficient of r=0.56 was found. The correlation was much stronger (r=0.86) when the protein content was taken into account along with the peak time. Based on the peak time and protein content, a nomogram was established to predict the baking results, but was valid only above 10% protein content (Sauer 1976).

When evaluating the mixograms, Sauer (1976) found that the angle, alpha, between the ascending and descending branches of the curve measured at the peak (top) were the most relevant characteristic of the mixogram (Fig. 4). With this angle, alpha, and the Zeleny sedimentation test and based upon multiple regression, equations were established for prediction farinogram and extensogram characteristics. According to these, the farinogram peak time and degree of softening can be predicted by the equations:

$$\text{peak time} = -2.78 \times 10^{-2} + 10^{-4}\ \text{Zeleny} + 2.76$$
(r= 0.75)

$$\text{degree of softening} = -2.60 \times 10^{-1}\text{alpha} - 8.45^{-3}\ \text{Zeleny} + 90.22$$
(r= 0.65)

For the extensogram data, these equations are valid:

$$\text{energy (area)} = 0.53\ \text{alpha} + 1.48\ \text{Zeleny} - 38.5$$
(r= 0.80)

$$\text{ratio: resistance / extensibility} = 2.34 \times 10^{-2}\ \text{alpha} - 7.46 \times 10^{-4}\ \text{protein content} + 0.22$$
(r= 0.65)

In conclusion, the Mixograph must be preferred over the time and material consuming Farinograph and extensograph methods in the early stages of breeding, because of its ability to predict wheat quality in terms of Farinography and extensography.

Another study was carried out with an Ottawa electronic recording dough mixer, providing more easily read curves. The original method using the Mixograph with spring damping produced unsteady and jumpy curves with wild deflections sometimes making the readings difficult. These disadvantages can be countered by adjusting the spring length and choosing the best position for the damping weights (Belderok 1977). It was also necessary to understand the sensitivity of the small dough batches to the air temperature and humidity in the laboratory environment, and the

importance to constantly control them.

In spite of these drawbacks and objections, another set of mixograms typical of European wheat varieties was presented by Belderok (1977) (Fig. 5). The necessity of using constant water absorption was explained, and as an adjustment for European wheat character and composition, a somewhat lower water addition (corresponding to 55% absorption) was recommended. By this method, a predictive nomogram for bake volume as a function of the protein content and peak time was developed (Fig. 6). The correlation coefficient between the predicted and actual bake volume, r=0.86, is a strong one indeed, but allows wheat variations up to 1.50 ml/100g flour (Fig. 7)(Belderok 1977). This Mixograph method, however, does not address the commercial milling properties. Therefore, breeding for high quality wheat requires other methods to reveal the structure and hardness of wheat kernels (Belderok 1977).

Several wheat varieties from different European countries, all grown in Sweden, have been compared by the use of the available screening and standard methods, including the Mixograph. In their two papers mixogram data for about 30 wheat varieties were published (Boggini and Nilsson 1976, Boggini et al. 1981). The developing slope, (ascending curve), the weakening slope (descending curve) and the angle between the two branches of the curve at the peak, were taken as mixogram characteristics, in addition to the time to peak. A number of strong and weak correlations were found among the mixogram measurements, baking test, farinogram data, and other chemical and physical analysis.

The angle between ascending and descending curves correlated strongly with protein and wet gluten contents, and the development time, stability and water absorption on the Farinograph. The correlation between the mixogram and baking volume did not seem to be satisfactory (Boggini and Nilsson 1976). Although the Farinograph and the Zeleny sedimentation test provided the best prediction of baking quality, the Mixograph was recommended as a good screening method for early stages of breeding where not only flours, but even whole kernel meals can be used for a first rheological screening. The final tests for wheat quality, however, must be performed by the Farinograph, extensograph, and baking trials (Boggini and Nilsson 1976).

When screening wheat varieties, a range from 9° to 55° for the Mixograph developing slope, and 1.5 to 9 min Farinograph developing time were observed. The recent screening of European wheat varieties from different countries, grown on several locations in Italy, have shown Mixograph times to peak from 1.45 to 6.0 min, peak heights from 38 to 60 mm, and water absorptions between 50.0 and 61.6 %. The correlations between peak height and bake volume (r=0.58) and water absorption (r=0.28) were not satisfactory, whilst the correlation of alveograph and Farinograph data to the bake volumes for the same materials seemed to be better (r=0.64 to 0.72, respectively).

After an intermission of several years, another attempt was made in 1983 and 1984 to examine the feasibility of the Mixograph method for screening European wheats. In his sabbatical year, professor Pomeranz initiated a project to adapt and introduce the Mixograph as a simple and quick but efficient method in wheat breeding (Pomeranz et al. 1983, Pomeranz et al. 1984). Based on previously published work with the Mixograph, and taking into consideration the situation in the European wheat market, the project had to answer whether or not the Mixograph was capable of describing the genetically linked dough properties which can also be environmentally influenced (Sauer 1976, Belderok 1977). Such papers carried out by those in the USA had not considered the specific characteristics of European wheat, or of European bread making procedures (Pomeranz 1983, Jeffers and Finney 1978, Finney et al. 1977, Finney et al. 1985). The genetically linked dough property characteristics are important for specific types of baked goods (wheat and rye mixed breads, toast bread, buns etc.) and for blending flours with the goals of optimizing their processing value as well as learning their reactions to oxidizing agents and improvers. Knowledge of the variety or its type is required, in addition to its protein content, Zeleny sedimentation value, and falling number, when selling and buying wheat.

For practical and academic reasons, the influences of the flour preparation method and protein content were studied prior to the start of the Mixograph work, which was aimed at providing recommendations to breeders. The flour preparation (grinding and sieving) with standard equipment (the Brabender Junior and the Buhler mills) did not change the pattern of the mixogram curves substantially, but the protein content of the flour should be considered when interpreting the mixograms (Pomeranz et al. 1983). The additional use of NIR for estimating protein content, hardness, and water absorption, was substantially helpful in wheat breeding. The water addition for mixograms should be corrected for protein content by 1.5% of water absorption for each 1% difference in protein content, according to recommendation made by Finney (Pomeranz et al. 1983). By evaluating a number of mixograms and by comparing the mixograms with baking results (loaf volume and sensory dough properties), typical mixograms were chosen which represented wheat with certain dough properties and thus baking behavior. German wheat varieties were classified into four main groups by dough properties, based upon the dough's surface feel and its elasticity. This twin estimation system for physical dough properties reported in the Rapid-Mix-Test baking trial is an important characteristic of each released wheat variety, and an important part of their description.

In addition to the baking trials, a flour or varieties dough properties are estimated, described, and explained by Extensograms, i.e. by the use of rheometry. The mixograms of wheat varieties classified into the four main groups by dough properties are presented in Figure 8/1 to 8/4 (Fig. 8). The typical flour quality, customary in commerce, is represented by the mixogram of "normal" dough properties, which is easily handled in the processing of common baked goods (Fig 8/1). Figure 8/2 shows the mixogram of a "dry on the surface, but short or stiff" dough, and Figure 8/3 characterizes a dough with "wet, but soft or slack" properties. Both these types are undesirable in bread processing, and need some adjustments prior to their use. The last mixogram, Figure 8/4, represents a dough of "somewhat wet, but silky"

properties - this is actually a quality grade of a wheat-improver (Pomeranz et al. 1984).

With knowledge of the protein content and a correction of the mixogram for protein content, mixograms can be usefully applied in breeding for quality wheat. For a set of over 40 samples (current wheat varieties), the coefficients of correlation for the relation between bake volume (Rapid-Mix-Test baking trial) vs. water absorption (r=0.617) and mixing time (r=0.656) were found. By correcting the peak time for protein content, a coefficient of correlation as high as r=0.868 was calculated. Some similarities in the mixograms of flours with normal dough properties but high protein contents, and stiff doughs but with low protein contents, were observed, and correction for protein content in the interpretation of mixograms recommended (Pomeranz et al. 1984).

In a continuation of the investigation evaluating the feasibility of the Mixograph method for classifying European wheats, the new European wheat market situation and the possible newly released varieties need to be considered. Since the low protein contents and the lower water absorptions of the European wheats were reported in the 70's, the quality of European wheat has been improved significantly in both characteristics (Sauer 1976, Belderok 1977). The German breeders have created wheats with genetically high quality potential which, combined with improved farming systems, have lead to high protein contents in wheat and flour, increasing their value. The average protein content for wheat crops has reached over 13%, and the baking quality as measured by bake volume, dough properties, and processing behavior are those of high quality wheats. Varieties with sticky dough properties have been virtually eliminated, and have been removed from the lists of recommended wheat varieties.

Therefore, the influence of water addition on mixograms and their characteristic values had first to be re-verified. The observed influence of absorption on peak height and time, on curve width, and on the mixogram ascending and descending slopes from both protein poor and rich flours was strongly pronounced, and has made the constant water Mixograph method impossible. Mixograms with a constant water addition proved to have a low predicting power for wheat quality, and the correction of water addition adjusted for the protein content was re-established (Pomeranz et al. 1984). The predicting ability of mixograms with corrected or adjusted water addition was significantly higher. Mixogram comparison made with the water absorption adjusted to protein content as recommended by Finney, with mixograms made with the estimated Farinograph water absorption has shown no significant advantage of one method over the other (Pomeranz et al. 1984). The water absorption by the damaged starch seemed to be addressed by the protein content correction in the samples investigated.

Sets of winter and spring wheat varieties were grown at different locations and therefore had flour protein contents from 10 - 15%, yielding bake volumes from 520 - 830ml/100g flour. The dough properties ranged from "wet and soft" through "normal" to "stiff". Mixograms were recorded and compared with the results of the sedimentation test, Farinograph, and Rapid-Mix-Test baking trial. Among the mixogram characteristics, time to peak showed a strong correlation with the bake volume (r=0.80) but somewhat less to the Farinogram mixing time and stability (r=0.63 to 0.76). The mixogram maximum peak height was highly correlated with the protein content and sedimentation value (r=0.82 to 0.84) and the Farinograph stability (r=0.76). The peak height of the mixograms at a constant water addition was expectedly more strongly correlated with the Farinograph water absorption (r=0.85) than for the mixograms with corrected water addition (r=0.65 to 0.72). This was also valid for the curve height after 7 min of mixing time. The curve widths (at peak and after 7 min) shared a good correlation with the Farinogram degree of softening (r=0.71 to 0.81), stability (r=0.45 to 0.84) and with the dough properties (r=0.68 to 0.77).

The reported regressions were calculated for the winter and spring wheats separately and jointly, giving different correlation coefficients. This may be due to the quality levels of the sample sets, in which the spring wheat was mainly of high quality, whilst the set of winter wheat varieties ranged from low to high quality. The results of the joint calculations, in which the high quality samples prevailed, were therefore chosen for presentation discussion.

**CONCLUSION**

To summarize this review over the uses and feasibility of the Mixograph as a method for assessment of wheat quality in Europe, it must be stated that the Mixograph has been tested and applied infrequently in Europe. The main reason for this situation must be seen as the competition against the other recording mixer developed at the same time in Europe. Both tests are performed frequently and the research work with the Mixograph was carried out with relatively small and limited numbers of samples. They were limited not only in number, but more disadvantageously, in the range of properties and quality characteristics.

The confidence in the abilities of the Mixograph to depict and predict the quality of wheat was somehow missing. The lack of experience and its interpretation have reduced the chances to demonstrate the Mixograph's usefulness to the extent that has been done in the USA. The use of the Farinograph in the practical and scientific cereal processing fields and its permanence in the minds of the processors has deep roots in Europe. It will always be hard for the Mixograph to compete with the Farinograph in Europe.

**REFERENCES**

Belderok, B. 1977. Der Mixograph als Hilfe bei der Weizenzüchtung auf Backqualität. Getreide Mehl und Brot 31:93-95.

Boggini, G., and Nilsson, G. 1976. Correlation between prediction tests and baking quality in winter wheat. Cereal Research Communications 4:3-16.

Boggini, G., Cattaneo, M., Corbellini, M., and Borghi, B. 1981. Prova comparative di frumenti teneri (1977-78): dati technologici. -technica molitoria 32:393-409.

Bourdet, A., Berrier, R., and Autran, G.C. 1976.

Appreciation de la force des bles tendres en selektion precoce. Etude comparee de differents tests miniaturises. -Ann. Amelior. Plantes 26:265-277.

Brabender, C. W. 1933. Studies with the Farinograph for predicting the most suitable types of American export wheats and flours for mixing with European soft wheats and flours. Cereal Chem. 10:617-627.

Brabender, C. W. 1934. Six years Farinography. Cereal Chem. 11:586-597.

Finney, K. F., Pomeranz, Y., Bolte, L. C., and Shogren, M. D. 1977. High-yielding European wheats - determination of end-use properties. Bakers Digest 51:28-30,32-34,368.

Finney, K. F., Heyne, E. G., Shogren, M. D., Bolte, L. C., and Pomeranz, Y. 1985. Functional properties of some European wheats grown in Europe and Kansas. Cereal Chem 62:83-88.

Günzel, G. 1982. Qualität und ihre züchterische Verwirklichung bei Brotweizen. Getreide Mehl Brot 36:253-255 .

Hoseney, R. C., and Finney, P. L. 1974. Mixing a contrary view. Bakers Digest 48:22-24,26,28,66.

Jeffers, H. C. and Rubenthaler, G. L. 1976. High-yielding European wheats - determination of pastry end-use properties. Bakers Digest 52:39-43.

Mani, K., Eliasson, A. C., Lindahl, L., and Tragardh, C. 1992. Rheological Properties and Breadmaking Quality of Wheat Flour Doughs Made with Different Dough Mixers. Cereal Chem. 69:222-225.

Muller, G. 1936. Der heutige Stand der Mehlqualitätsbewertung mittels physikalischer Mebverfahren. Zeitschrift für das gesamte Getreide-, Mühlen- und Bäckereiwesen 23:104-116.

Pomeranz, Y., Bolling, H., Weipert, D., and Zwingelberg, H. 1984. Beurteilung deutscher Weizensorten mit Hilfe des Mixographen. Mühle + Mischfuttertechnik 121:307-308;310.

Pomeranz, Y., Zwingelberg, H., and Weipert, D. 1983. Der Mixographeine Methode zur Beurteilung der Qualität von deutschen Weizensorten?. Mühle + Mischfuttertechnik 121:530-541.

Sauer, W. 1976. Early detection of quality characteristics as a basis for effective selection in wheat breeding. II. Evaluation of physical dough properties by the mixogram. Fruehzeitige Erfassung von Qualitaetsmerkmalen als Grundlage fuer eine wirkungsvolle Selektion in der Weizenzuechtung. II. Das Mixogramm als Mass fuer teigphysikalische Kriterien. Muehle × Mischfuttertechnik. 113(33):453-455.

Swanson, C. O. and Working, E. B. 1933. Testing the quality of flour by the recording dough mixer. Cereal Chem. 10(1):1-29.

Svenson, G. 1984. The Mixograph in the breeding for baking quality. Pages 369-378 in: Proceedings from 22nd Nordic Area Congress: Lillehammer.

Weipert, D. 1987. Evaluation of mixing intensity of recording mixers used in studies of dough rheology. Beurteilung der Knetintensitaet der in der Teigrheologie eingesetzten registrierenden Kneter. Muehle Mischfuttertechnik. 124(12):147-151.

Weipert, D. 1989. IKAVISC-Mebrührer als registrierender Kneter in der Teigrheologie. IKAVISC-Anwender-Symposium Neue Wege in der präparativen Viskositätsmessung Waldkirch September. p. 29-27.

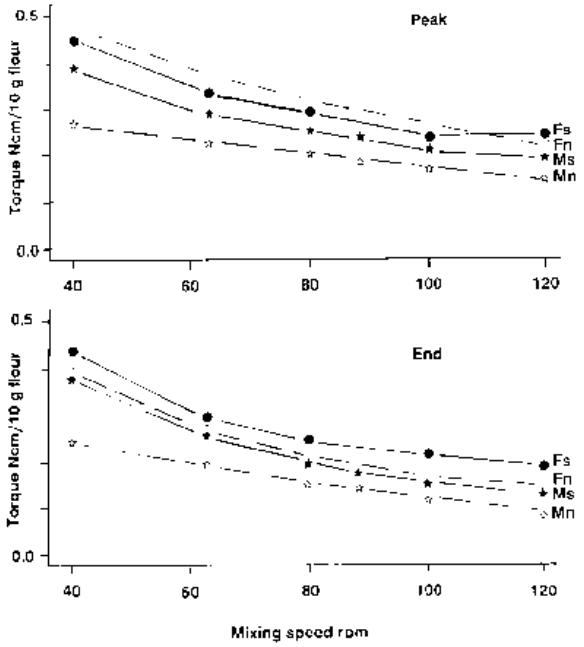



Fig. 1 Torque values of doughs from wheat flours of strong and weak gluten, as mixed in a Farinograph and Mixograph mixer at different mixing speeds. (from Weipert 1989).

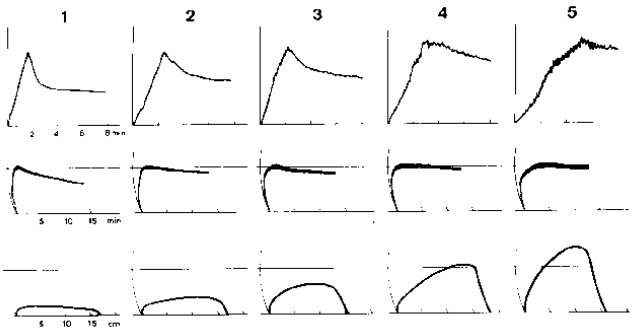



Fig. 2 Types of characteristic mixograms in comparison with farinograms and extensograms. (from Sauer 1976).

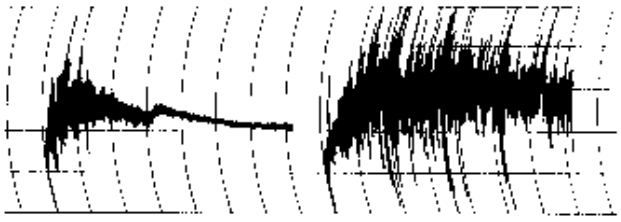


Fig. 3 Typical mixograms of wet and sticky wheat doughs (wheat variety Clement-type) and of stiff dough (wheat variety Felix-type). (from Belderok 1977).

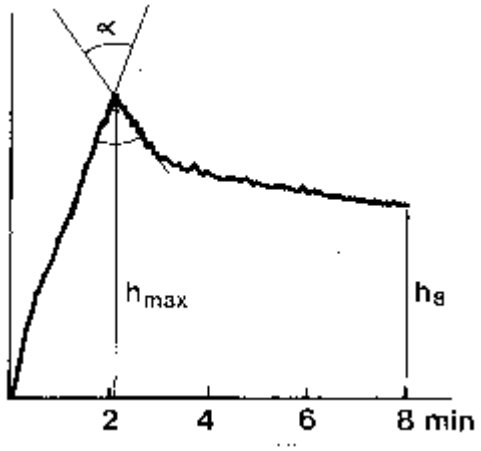



Fig. 4 A possible reading for evaluation of the mixograms. (from Sauer 1976).

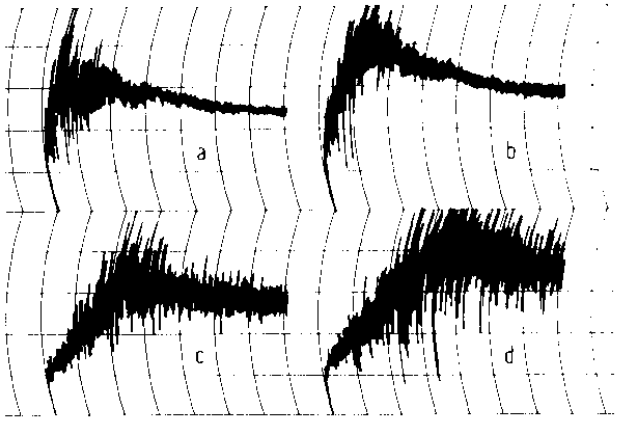



Fig. 5 Characteristic mixograms with increasing dough development times and decreasing dough weakening angles. (from Belderok 1977).

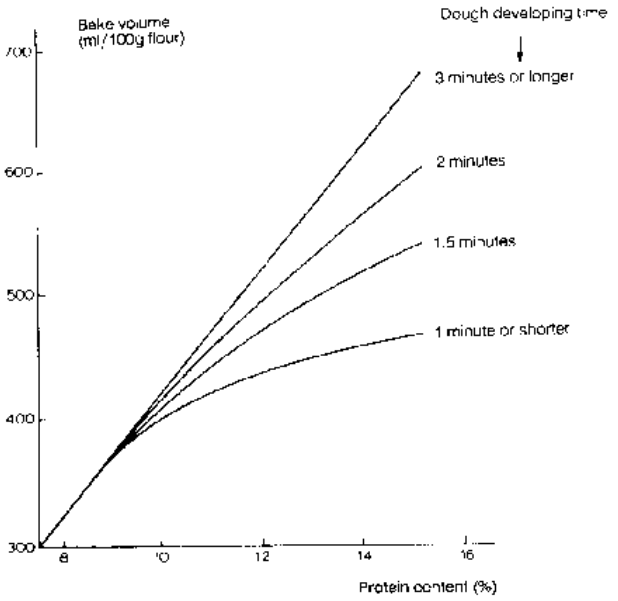



Fig. 6 Nomogram, showing the relationship time for mixogram peak and the protein content for predicting baking volume. (from Belderok 1977).

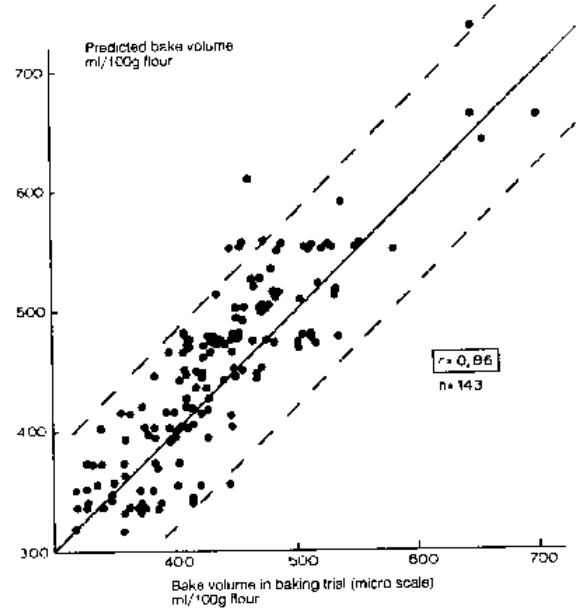



Fig. 7 Correlation between the actual bake volume and bake volume predicted by mixogram data and protein content. (from Belderok 1977).

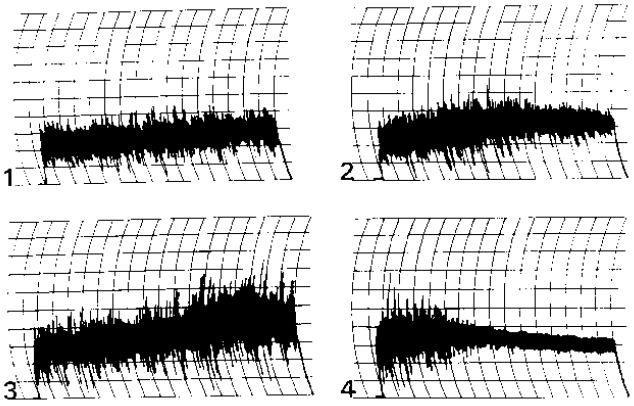



Fig. 8 Typical mixograms from German wheat varieties having different dough properties. (from Pomeranz et al. 1984).

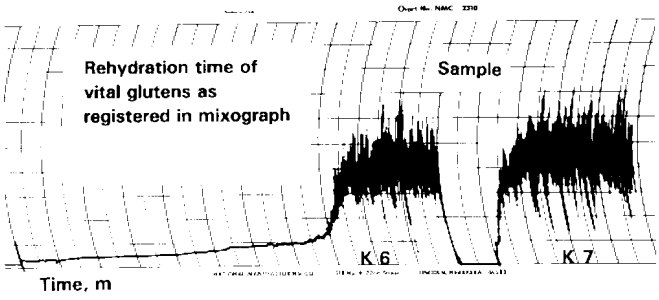



Fig. 9 Mixograph curves of rehydrated vital gluten: K 6 of slow, K 7 of quick water binding and structure building properties.

# TABLE 1

## Dough Viscosity, Pa's*

| | *Constant Water Addition, 56% WA* | | | | | |
|---|---|---|---|---|---|---|
| | Diff. from Farinograph | | Farinograph | | Mixograph | |
| Wheat variety | WA | Peak | 7 min | 20 min | Peak | 7 min |
| CWRS | -3.6 | 3610 | 3548 | 2676 | 4042 | 3073 |
| Schirokko | -2.3 | 2863 | 2800 | 2427 | 3185 | 2739 |
| Ralle | -0.8 | 2241 | 2676 | 2400 | 2895 | 2313 |
| Okapi | +2.7 | 2490 | 1680 | 1245 | 1793 | 1141 |
| Aquilla | +2.9 | 1494 | 1369 | 1245 | 1649 | 1400 |
| M. Huntsman | -5.9 | 2988 | 2552 | 1432 | 3065 | 1510 |
| | *Water Addition According to the Farinograph WA* | | | | | |
| | Farinograph | | Farinograph | | Mixograph | |
| Wheat variety | WA | Peak | 7 min | 20 min | Peak | 7 min |
| CWRS | 59.6 | 2241 | 2490 | 1992 | 2839 | 2240 |
| Schirokko | 58.3 | 2365 | 1992 | 2054 | 2645 | 2334 |
| Ralle | 56.8 | 2241 | 2178 | 2583 | 2303 | ---- |
| Okapi | 53.3 | 2241 | 1929 | 934 | 2521 | 1666 |
| Aquilla | 53.1 | 2116 | 1929 | 1494 | 2552 | 1992 |
| M. Huntsman | 61.0 | 2365 | 1929 | 1681 | 1909 | 996 |

* Viscosity from the stress-strain curve at constant strain D = 1.11-$sec^{-1}$

# APPENDICES

# APPENDIX I

Mixograph References

# GENERAL MIXOGRAPH/MIXOGRAM REFERENCES


Abou-Guendia, M. and D'Appolonia, B.L. 1972. Effect of stage of maturity on composition and baking quality of hard red spring wheat. Bakers' Digest. 46(5):45-46, 48-50, 65.

Abrol, Y. P., Singh, D., Uprety, D. C., and Singh, B. 1972. Correlation of mixogram characteristics with percentage of protein, Pelshenke value and loaf volume of wheat (Triticum aestivum L.):Indian J. Agricultural Sci. 42(6):443-447.

Ali Doust M, Anzalone SL, Impiombato D. 1993. Chemical control of pathological diseases of durum wheat: influence on the semolina technological quality. Tecnica Molitoria. 44(7):577-582.

Al-Khawlani, M. A. 1989. The relationship of gliadin and glutenin subunits to breadmaking characteristics in winter wheat. Dissertation Abstracts International. B. 49(8):2933-2934.

American Association of Cereal Chemists. 1991. Approved Methods of the AACC, 8th ed. Method 54-40A, approved April 1961, revised Oct. 1988. The Association: St. Paul, MN.

Austin, A., Singh, H. D., and Sadasivan, G. 1973. Varietal and nitrogen effects on dough characters and protein content of some new high yielding wheat varieties. Acta Agronomica Academiae Scientiarum Hungaricae. 22(½):105-114.

Baig, M. M. and Hoseney, R. C. 1977. Effects of mixer speed, dough temperature, and water absorption on flour-water mixograms. Cereal Chem. 54(3):605-615.

Baik B. K., Czuchajowska Z, Pomeranz Y. 1994. An SDS FY test to evaluate quality of wheat for oriental noodles. J. Cereal Sci. 20(2):191-201.

Baker, R. J. and Campbell, A. B. 1971. Evaluation of screening tests for quality of bread wheat. Canadian J. Plant Sci. 51(6):449-455.

Baker, R. J. and Dyck, P. L. 1975. Relation of several quality characteristics to hardness in two spring wheat crosses. Canadian J. Plant Sci. 55(2):625-627.

Baker, R. J. and Kosmolak, F. G. 1977. Effects of genotype-environment interaction on bread wheat quality in western Canada. Canadian J. Plant Sci. 57(1):185-191.

Bakshi, A. K., Bawa, A. S., Sekhon, K. S., and Saxena, A. K. 1984. Effect of improvers on rheological characteristics of some wheat and triticale varieties. J. Res. Punjab Agr. Univ. 21(4):477-482.

Bakhshi, A. K., Gill, K. S., Sandha, G. S., and Dhinsa, G. S. 1976. Rheological and physico-chemical properties of triticales. J. Food Sci and Techn.. India. 13(1):48-49.

Bakshi, A. K., Sekhon, K .S., and Gill, K. S. 1979. Milling, baking and chapati-making characteristics of some triticale strains. Pages 45-46, in: Proceedings of the First Indian Convention of Food Sci. and Techn.

Bendelow, V. M. 1967. Early-generation screening for gluten strength in durum wheat breeding. Cereal Sci. Today 12(8):336-337.

Batey, I. L. 1983. Chemical modification of lysine residues in wheat gluten with potassium cyanate. J. Cereal Sci. 1(1):71-76.

Batey, I. L. 1980. Chemical modification as a probe of gluten structure. Annales de Technologie Agricole. 29(2):363-375.

Bekes, F, Gras P. W., and Gupta, R. B. 1994. Mixing properties as a measure of reversible reduction and oxidation of doughs. Cereal Chem. 71(1):44-50.

Bekes, F., Gras, P. W., Gupta, R. B., Hickman, D. R., Tatham, A. S. 1994. Effects of a high Mr glutenin subunit (1B x 20) on the dough mixing properties of wheat flour. J. Cereal Sci. 19(1):3-7.

Bettge, A., Rubenthaler, G. L., Pomeranz, Y. 1989. Air-aspirated wheat cleaning in grading and in separation by functional properties. Cereal Chem. 66(1):15-18, 22.

Bettge, A, Rubenthaler, G. L., Pomeranz, Y. 1989. Air aspirated wheat cleaning in grading and in separation by functional properties. Bulletin Assoc. of Operative Millers Sept. 5545-5550.

Belderok, B. 1977. The use of the mixograph as an aid to assessing baking quality in wheat breeding. Der Mixograph als Hilfe bei der Weizenzuechtung auf Backqualitaet. Getreide, Mehl und Brot. 31(4):93-95.

Bhatty, R. S. 1986. Physicochemical and functional (breadmaking):properties of hull-less barley fractions. Cereal Chem. 63(1):31-35.

Biliaderis, C. G., Izydorczyk, M. S., Lukow, O. M., and Bushuk, W. 1992. Pentosans in flours of 1B/1R translocation wheats. Cereal Chem. 69(2):226-228.

Blumenthal, C., Bekes, F., Gras, P. W., Barlow, E. W. R., and Wrigley, C. W. 1995. Identification of wheat genotypes tolerant to the effects of heat stress on grain quality. Cereal Chem. 72(6):539-544.

Blumenthal C, Gras PW, Bekes F, Barlow EWR, Wrigley CW. 1995. Possible role for the Glu D1 locus with respect to tolerance to dough quality change after heat stress. Cereal Chem. 72(1):135-136.
Boggini, G. 1980. Techn. of soft wheat. Panificazione and Pasticceria. 8(5):39-41, 43.
Boggini, G. and Borghi, B. 1978. Comparative studies on winter wheats grown in Italy in 1975/1976: technological data. Tecnica Molitoria. 29(9):591-612.
Boggini, G. and Corbellini, M. 1979. Comparative studies on soft wheats in 1976/77: technological data. Tecnica Molitoria. 30(5):345-361.
Boggini, G., Cattaneo, M., Corbellini, M., and Borghi, B. 1981. Comparative trials on soft wheats grown in 1977/1978. Technological data. Tecnica Molitoria. 32(6):393-409.
Boggini, G., Corbellini, M., Pogna, N. E., and Borghi, B. 1981. Comparative studies on bread wheats in 1978-79 and 1979-80: technological data. Tecnica Molitoria. 32(12):805-828.
Boggini, G., and Nilsson, G. 1976. Correlation between prediction tests and baking quality in winter wheat. Cereal Research Communications 4:3-16.
Boggini, G. and Pogna, N. E. 1989. The breadmaking quality and storage protein composition of Italian durum wheat. J. Cereal Sci. 9(2):131-138.
Boggini, G., Tusa, P., and Pogna, N. E. 1995. Bread making quality of durum wheat genotypes with some novel glutenin subunit compositions. J. Cereal Sci. 22(2):105-113.
Boland, O. W. and Walcott, J. J. 1985. Levels of heterosis for yield and quality in a F1 hybrid wheat. Australian J. Agr. Res. 36(4):545-552.
Bourdet, A. and Berrier, R. 1979. Baking quality of wheats evaluated on the basis of the mixing behavior of doughs. Annales de Technologie Agricole. 28(1):79-105.
Bourdet, A., Berrier, R., and Autran, J. C. 1976. Strength estimation in early varieties of wheat. Comparative study of small-scale tests. Annales de Technologie Agricole. 26(2):265-277.
Boyacioglu, M. H., Dick, J. W., D'Appolonia, B. L. 1991. A comparison of the Chopin Dubois and modified Buhler durum wheat laboratory mills. Cereal Foods World 36(10):893-896.
Branlard, G., Rousset, M., Loisel, W., and Autran, J. C. 1991. Comparison of 46 technological parameters used in breeding for bread wheat quality evaluation. J. Genetics & Breeding 45(4):263-280.
Bruinsma, B. L. 1980. Nutritional and functional properties of peas as a fortifier of wheat flour. Dissertation Abstr. Intern. B. 41(1):120.
Bruinsma, B. L., Anderson, P. D., and Rubenthaler, G. L. 1978. Rapid method to determine quality of wheat with the mixograph. Cereal Chem.. 55(5):732-735.
Buchholz, R. H. 1990. An epitrochoidal mixer. Math Sci. 15:7-14.
Buckley, D. J., Lunkow, O. M., Lalonde, J. L. M., and Woods, S. M. 1958. A multilevel cumputer system for dough quality analysis and report distribution. Cereal Foods World. 35(5):472.
Burnett, C. J., Lorenz, K. J., and Carver, B. F. 1995. Effects of the 1B/1R translocation in wheat on composition and properties of grain and flour. Euphytica, 86(3):159-166.
Busch, R. H., Shuey, W. C., and Frohberg, R. C. 1969. Response of hard red spring wheat (Triticum aestivum L.) to environments in relation to six quality characteristics. Crop Sci. 9(6):813-817.
Butaki, R. C. and Dronzek, B. 1979. Comparison of gluten properties of four wheat varieties. Cereal Chem. 56(3):159-161.
Byung Kee Baik, Czuchajowska, Z., Pomeranz, Y. 1994. Role and contribution of starch and protein contents and quality to texture profile analysis of oriental noodles. Cereal Chem. 71(4):315-320.
Cadden, A. M., Sosulski, F. W., and Olson, J. P. 1983. Physiological response of rats to high fiber bread diets containing several sources of hulls or brans. J. Food Sci. 48(4):1151-1156.
Carver, B. F. 1994. Genetic implications of kernel NIR hardness on milling and flour quality in bread wheat. J. the Sci. of Food and Agr. 65(1):125-132.
Carver, B. F. and Lane-Rayburn, A. 1995. Comparison of related wheat stocks possessing 1B or T1BL 1RS chromosomes: grain and flour quality. Crop Sci. 35(5):1316-1321.
Chen, H., Rubenthaler, G. L., and Schanus, E. G. 1988. Effect of apple fiber and cellulose on the physical properties of wheat flour. J. Food Sci. 53(1):304-305.

Chen, W. Z. and Hoseney, R.C. 1995. Wheat flour compound that produces sticky dough: Isolation and identification. J. Cereal Sci. 60(3):434-437.
Chung, O. K., Pomeranz, Y., Finney, K. F., and Shogren, M. D. 1978. Defatted and reconstituted wheat flours. III. Effects of flour moisture content and aqueous binary azeotropes on functional (breadmaking) properties. Cereal Chem. 55(1):31-43.
Ciaffi, M., Lafiandra, D., Turchetta, T., Ravaglia, S., Bariana, H., Gupta, R., and MacRitchie, F. 1995. Breadbaking potential of durum wheat lines expressing both X and Y type subunits at the Glu A1 locus. Cereal Chem. 72(5):465-469.
Cox, D. J. and Shelton, D. R. 1992. Genotype by tillage interactions in hard red winter wheat quality evaluation. Agronomy Journal 84(4):627-630.
Cubadda, R. 1991. Flour characteristics and bread quality. Tecnica Molitoria 42(2):89-96.
Czuchajowska, Z., and Pomeranz, Y. 1990. Quest for a universal test of commercial gluten quality for breadmaking. Cereal Foods World. 35(5):458.
Dachkevitch, T. and Autran, J. C. 1989. Prediction of baking quality of bread wheats in breeding programs by size exclusion high performance liquid chromatography. Cereal Chem. 66(6):448-456.
Danno, G. and Hoseney, R. C. 1982. Effect of sodium chloride and sodium dodecyl sulfate on mixograph properties. Cereal Chem. 59(3):202-204.
D'Appolonia, B. L., Shuey, W. C., Sibbitt, L. D., and Gilles, K. A. 1971. Relations between mixing requirements of flour using a continuous baking unit and conventional laboratory mixers. Cereal Sci. Today. 16(7):206,208-209.
Delzer, B. W., Busch, R. H., and Hareland, G. A. 1995. Recurrent selection for grain protein in hard red spring wheat. Crop Sci. 35(3):730-735.
Dexter, J. E., Marchylo, B. A., and Mellish, V. J. 1994. Effects of frost damage and immaturity on the quality of durum wheat. Cereal Chem. 71(5):494-501.
Dexter, J. E, Matsuo, R. R, and Daniel, R. W. 1989. The influence of heat damage on durum wheat spaghetti quality. Canadian Institute of Food Sci. and Techn. J. 22(3):227-237.
Dexter, J. E., Matsuo, R. R., Kosmolak, F. G., Leisle, D., and Marchylo, B. A. 1980. The suitability of the SDS-sedimentation test for assessing gluten strength in durum wheat. Canadian J. Plant Sci. 60(1):25-29.
Dexter, J. E., Preston, K. R., Martin, D. G., and Gander, E. J. 1994. The effects of protein content and starch damage on the physical dough properties and bread-making quality of Canadian durum wheat. J. Cereal Sci. 20(2):139-151.
Dhaliwal AS, MacRitchie F. 1990. Contributions of protein fractions to dough handling properties of wheat rye translocation cultivars. J. Cereal Sci. 12(2):113-122.
Dhaliwal, A. S., Mares, D. J., Marshall, D. R., and Skerritt, J. H. 1988. Protein composition and pentosan content in relation to dough stickiness of 1B/1R translocation wheats. Cereal Chem. 65(2):143-149.
Dick, J. W. 1976. Manipulation of hard red spring wheat flour quality by fine grinding and air classification. Dissertation Abstracts International. B, 37(6):2746.
Dick, J. W. and Quick, J. S. 1983. A modified screening test for rapid estimation of gluten strength in early-generation durum wheat breeding lines. Cereal Chem. 60(4):315-318.
Dick, J. W., Shuey, W. C., and Banasik, O. J. 1977. Adjustment of rheological properties of flours by fine grinding and air classification. Cereal Chem. 54(2):246-255.
Dick, J. W., Shuey, W. C., and Banasik, O. J. 1979. Bread-making quality of air-classified hard red spring wheat manipulated flour blends. Cereal Chem. 56(5):480-485.
Doescher, L. C. and Hoseney, R. C. 1985. Evaluation of commercial cracker flours by test baking and study of changes occurring during sponge fermentation. J. Cereal Sci. 3(3):261-270.
Dong, H., Sears, R. G., Cox, T. S., Hoseney, R. C., Lookhart, G. L., and Shogren M. D. 1992. Relationships between protein composition and mixograph and loaf characteristics in wheat. Cereal Chem. 69(2):132-136.
Dong, W. and Hoseney, R. C. 1995. Effects of certain breadmaking oxidants and reducing agents on dough rheological properties. Cereal Chem. 72(1):58-64.
Dougherty, D. A., Wehling, R. L., Zeece, M. G., and Partridge, J. E. 1990. Evaluation of selected baking quality factors of hard red winter wheat flours by two dimensional electrophoresis. Cereal Chem. 67(6):564-569.
Dreese, P. C. and Hoseney, R. C. 1990. The effect of water extracded solubles from gluten on its baking and rheological properties. Cereal Chem. 67(4):400-404.
Drijepondt, S. C., Pretorius, Z. A., Van Lill, D., and Rijkenberg, F. H. J. 1990. Effect of Lr34 resistance on leaf rust development, grain yield and baking quality in wheat. Plant Breeding 105(1):62-68.

Du-Cros, D. L., Wrigley, C. W., and Hare, R. A. 1982. Prediction of durum-wheat quality from gliadin-protein composition. Australian J. Agricultural Research. 33(3):429-442.
Dyck, P. L. and Baker, R. J. 1975. Variation and covariation of agronomic and quality traits in two spring wheat populations. Crop Sci. 15(2):161-165.
Eaton, D. L. 1984. The incorporation of unadapted germplasm into adapted spring wheat cultivars. Dissertation Abstr. Intern., -B. 44(9):2622.
El-Minyawi, M. A. and Zabik, M. E. 1981. Cottonseed flour's functionality in Egyptian baladi bread. Cereal Chem. 58(5):413-417.
Endo, S., Tanaka, K., and Nagao, S. 1985. Studies on dough development. II. Effects of mixing apparatus and mixing speed on the rheological and analytical properties of heated dough. Cereal Chem. 62(4):272-275.
Fajersson, F. and Svensson, G. 1982. [Weibulls Kadett - a new spring wheat cv. for southern Sweden, the Federal Republic of Germany and Denmark.] Weibulls Kadett-eine neue Sommerweizensorte fuer Sued-Schweden, die Bundesrepublik Deutschland und Daenemark. Agri Hortique Genetica. 40, 29-50.
Faridi, H. [Editor] 1985. Rheology of wheat products. Amer. Assoc. Cereal Chem.: St. Paul, MN.
Faridi, H. and Faubion, J. M. [Editors] 1986. Fundamentals of dough rheology. Amer. Assoc. Cereal Chem.: St. Paul, MN.
Fernandes, J. L. A., Shuey, W. C., and Maneval, R. D. 1979. Bread wheat granular mill streams with potential for pasta production. Effect of crop year, wheat classes and eggs on processing spaghetti. Cereal Chem. 56(6):520-524.
Fernandes, J. L. A., Shuey, W. C., and Maneval, R. D. 1978. Bread wheat granular millstreams with a potential for pasta production. I. Physical and analytic properties. Cereal Chem. 55(3):308-320.
Fifield, C. C. 1970. Quality characteristics of wheat treated with four inert dusts for protection against insects during storage. Northwestern Miller. 277(12):9-14.
Finney, K. F. 1945. Methods of estimating and effects of variety and protein content level on the baking quality of flour. Cereal Chem. 22(2):149-158.
Finney, K. F. 1989. A five-gram mixograph to determine and predict functional properties of wheat flours. Cereal Chem. 66(6):527-530.
Finney, K. F. and Barmore, M. A. 1948. Loaf volume and protein content of hard winter and spring wheats. Cereal Chem. 25(5):291-312.
Finney, K. F. and Bolte, L. C. 1985. Experimental micromilling: reduction of tempering time of wheat from 18-24 hours to 30 minutes. Cereal Chem. 62(6):454-458.
Finney, K. F., Heyne, E. G., Shogren, M. D., Bolte, L. C., and Pomeranz, Y. 1985. Functional properties of some European wheats grown in Europe and Kansas. Cereal Chem. 62(2):83-88.
Finney, K. F., Morris, V. H. and Yamazaki, W. T. 1950. Micro versus Macro cooking baking procedures for evaluating the cookie quality of wheat varieties. Cereal Chem. 27(1):42-49.
Finney, K. F., Pomeranz, Y., Bolte, L. C., and Shogren, M. D. 1977. High-yielding European wheats - determination of end-use properties. Bakers' Digest. 51(1):28-30, 32-34, 36.
Finney, K. F., Pomeranz, Y., Bolte, L. C., and Shogren, M. D. 1977. [High-yielding European wheats: evaluation of their processing quality.] Hochertragreiche europaeische Weizensorten: Beurteilung des Verarbeitungswertes. Getreide, Mehl und Brot. 31(3):57-63.
Finney, K. F. and Shogren, M. D. 1972. A ten-gram mixograph for determining and predicting functional properties of wheat flours. Bakers' Digest. 46(2):32-35, 38-42, 77.
Finney, K .F., Tsen, C. C., and Shogren, M. D. 1971. Cysteine's effect on mixing time, water absorption, oxidation requirement, and loaf volume of Red River 68. Cereal Chem. 48(5):540-544.
Finney, K. F., and Yamazaki, W. T. 1967. Quality of hard, soft and durum wheats. Pages 471-503 in: Wheat and Wheat Improvement. K. S. Quisenberry and L. P. Reitz, eds. Am. Soc. Agr. Inc.: Madison, WI.
Finney, K. F., and Yamazaki, W. T. 1987. Quality of hard, soft and durum wheats. Pages 677-741 in: Wheat and Wheat Improvement. E. G. Heyne, ed. Am. Soc. Agr. Inc.: Madison, WI.
Finney, P. L. 1973. Milling, chemical, rheological and breadmaking properties of Indian wheats. Dissertation Abstr. Intern., B. 33(12, Part 1):5900.
Fenn, D., Lukow, O. M., Bushuk, W., and Depauw, R. M. 1994. Milling and baking quality of 1BL/1RS translocation wheats. I. Effects of genotype and environment. Cereal Chem. 71(2):189-195.
Fjell, K. M. [Editor] 1984. Proceedings from 22nd Nordic cereal congress. June 12-14 1984, Lillehammer, Norway.
Fleming, S. E. 1976. Breadmaking and nutritional quality of concentrated plant proteins. Dissertation Abstr. Intern., B. 36(12):6047-6048.

Fleming, S. E. and Sosulski, F. W. 1977. Breadmaking properties of four concentrated plant proteins. Cereal Chem. 54(5):1124-1140.
Fleming, S. E. and Sosulski, F. W. 1974. Dough conditioners in wheat-soy-gluten breads. Canadian Institute of Food Sci and Techn. J. 7(1):51-55.
Fowler, D. B. and Roche, I. A. de la 1984. Winter wheat production of the north central Canadian prairies: potential quality classes. Crop Sci. 24(5):873-876.
Francois, L. E., Maas, E. V., Donovan, T. J., and Youngs, V. L. 1986. Effect of salinity on grain yield and quality, vegetative growth, and germination of semi-dwarf and durum wheat. Agronomy J. 78(6):1053-1058.
Fu, B. X. and Sapirstein, H. D. 1996. Procedure for isolating monomeric proteins and polymeric glutenin of wheat flour. Cereal Chem. 73(1):143-152.
Gaines, C. S. 1990. Influence of chemical and physical modification of soft wheat protein on sugar snap cookie dough consistency, cookie size, and hardness. Cereal Chem. 67(1):73-77.
Germani, R. 1987. Comparison of some physical and biochemical characteristics of hard red spring and hard red winter wheats. Dissertation Abstr. Intern., B. 47(8):3184.
Gill, K. S., Sehgal, K. L., and Gill, M. S. 1974. Quality characteristics of three improved varieties of wheat in the Punjab. J. Food Sci and Techn. India. 11(1):22-24.
Gras, P. W., Hibberd, G. E., and Walker, C. E. 1990. Electronic sensing and interpretation of dough properties using a 35-g mixograph. Cereal Foods World 35(6):568-571.
Gras, P. W, and O'Brien, L. 1992. Application of a 2 gram mixograph to early generation selection for dough strength. Cereal Chem. 69(3):254-257.
Gras, P. W., Walker, C. E., and Rath, C. R. 1992. Use of laboratory mixers as models for commercial mixers. Pages 42-46 in: Symp. Proceedings, 42nd RACI Cereal Chem. Conference: Christchurch, New Zealand.
Graybosch, R. A, Peterson, C. J., Hansen, L. E., Worrall, D., Shelton, D. R., and Lukaszewski, A. 1993. Comparative flour quality and protein characteristics of 1BL/1RS and 1AL/1RS wheat rye translocation lines. J. Cereal Sci. 17(2):95-106.
Gould, J. M., Jasberg, B. K., and Dexter, L. 1990. Effects of alkaline hydrogen peroxide treated fiber ingredients on mixograph properties of wheat flour dough. Lebensmittel Wissenschaft und Technologie 23(4):358360.
Günzel, G. 1982. Qualität und ihre züchterische Verwirklichung bei Brotweizen. Getreide Mehl Brot 36:253-255 .
Gupta, R. B., Batey, I. L., and MacRitchie, F. 1992. Relationships between protein composition and functional properties of wheat flours. Cereal Chem. 69(2):125-131.
Halim, M. A. and Lorenz, K. 1985. High fiber Sudanese breads. Nutr. Rep.Intl. 31:91.
Haridas Rao P, Malini Rao H. 1991. Effect of incorporating wheat bran on the rheological characteristics and bread making quality of flour. J. Food Sci. and Techn. India 28(2):92-97.
Harris, R. H., Sibbet, L. D., and Scott, G. M. 1944. The effect of temperature differences on some mixogram properties of hard red spring wheat flours. Cereal Chem. 21(5):375-385.
Hazelton, J. L. 1994. Mixograph head pin position and other factors affecting mixograms. MS Thesis, Kansas State University, Manhattan, KS.
Hazelton, J. L., Chung, O. K. Eastman, J. J., Lang, C. E., McCluskey, P. J., Miller, R. A., Shipman, M. A., and Walker, C. E. 1997. Regression equation for predicting absorption for 2-g Direct Drive Mixograph. Cereal Chem. 74(4):400-402.
Hazelton, J. L., Shaskikumar, K., Ryu, G. H., and Walker, C. E. 1994. Predicting mixing parameters by near infrared reflectance analysis. National Notes 1(2):13-15.
Hazelton, J. L. and Walker, C. E. 1993. Effects of number of bowl pins on moving and fixed bowl mixograms. National Notes 1(1):2-7.
Hazelton, J. L. and Walker, C. E. 1994. Effect of potential contaminants on mixograms properties. National Notes 1(4):2-4.
Hazelton, J. L. and Walker, C. E. 1994. Use of teflon coatings on mixograph head and bowls. National Notes 1(3):6-10.
Hazelton, J. L. and Walker, C. E. 1995. Sample size induced changes in mixogram parameters. National Notes 2(2):2-4.
Hazelton, J. L. and Walker, C. E. 1995. Measuring temperature rise during mixing at various mixograph bowl positions. National Notes 2(3):2-6.
Hazelton, J. L. and Walker, C. E. 1995. Effects of bowl platform rotation on fixed bowl mixograms. National Notes 2(3):12-14.
Hazelton, J. L. and Walker, C. E. 1995. Effects of number of bowl pins on mixograms: Supplemental. National Notes 2(3):18-19.
Hazelton, J. L. and Walker, C. E. 1996. Changing mixogram appearance by sampling at fixed as opposed to random head position. Cereal Foods World 41(7):631-634.
Hazelton, J. L. and Walker, C. E. 1995. Sample frequency effects on mixograms. Cereal Chem. 72(4):368-370.

Hazelton, J. L. and Walker, C. E. 1994. Changes in mixograms resulting from variations in shear caused by different bowl pin sizes. Cereal Chem. 71(6):632-634.
Halim, M. A. and Lorenz, K. 1985. High fiber Sudanese breads. Nutrition Reports Intern. 31(1):91-102.
He, H., Roach, R. R., and Hoseney, R. C. 1992. Effect of nonchaotropic salts on flour bread making properties. Cereal Chem. 69(4):366-371.
Heizer, H. K., Moser, L., Bode, E. E., Yamazaki, W. T., and Kissell, L. T. 1951. Studies concerning mixograph standardization. Transactions of the Am. Assoc. of Cereal Chem. 9:16.
Hibberd, G. E and Gras, P. W. 1989. Evaluation of dough development in laboratory and commercial scale mixers. Pages 529-534 in: Proceedings from ICC'89 symposium. Wheat end use properties.: Wheat and flour characterization for specific end uses. University of Finland: Helsinki, Finland.
Holmes, J. T. and Hoseney, R. C. 1987. Chemical leavening: effect of pH and certain ions on breadmaking properties. Cereal Chem. 64(5):343-348.
Hoseney, R. C. 1985. The mixing phenomenon. Cereal Foods World. 30(7):453-457.
Hoseney, R. C. and Brown, R. A. 1983. Mixograph studies. V. Effect of pH. Cereal Chem. 60(2):124-126.
Hoseney, R. C. and Finney, P. L. 1974. Mixing. A contrary view. Bakers' Digest. 48(1):22-24, 26, 28, 66.
Hoseney, R. C., Rao, H., Faubion, J., and Sidhu, J. S. 1980. Mixograph studies. IV. The mechanism by which lipoxygenase increases mixing tolerance. Cereal Chem. 57(3):163-166.
Huang, S., Betker, S., Quail, K., and Moss, R. 1993. An optimized processing procedure by response surface methodology (RSM) for northern-style Chinese steamed bread. J. Cereal Sci. 18(1):89-102.
Huebner, F. R. 1978. Influence of composition on wheat flour dough performance. Sci and Edu. Admin., U.S. Dept of Agr. ARM W 4, 128-139.
Hylnka, I. 1970. Rheological properties of dough and their significance in the breadmaking process. Baker's Digest April:40.
Hyon Suk Song and Hong Suk Lee. 1993. Selection efficiency for protein content and sedimentation value in progenies of hybridized wheat. Korean J. Crop Sci. 38(1):8-14.
Hyon Suk Song, Hong Suk Lee, and Tae Young Chung. 1994. Cooking and milling characteristics of several barley starch isogenic lines. Korean J. Crop Sci. 39(1):63-72.
Indrani, D., Savithri, G. D., Venkateswara-Rao, G. 1992. Effect of onion extract on the rheological and bread making characteristics of wheat flour. J. Food Sci. and Techn. India 29(3):150-152.
Ingelin, M. E. 1995. Measurement of Dough Properties and Their Use in Predicting White Pan Bread Quality. Ph.D. dissertation. Department of Grain Science and Industry, Kansas State University, Manhattan, KS.
Ingelin, M., Dogan, I., Ponte, J. G. Jr., and Jones, B. 1994. Objective measurement of bakery mix times. National Notes 2(1):7-9.
Jasberg, B. K, Gould, J. M, Warner, K., and Navicks, L. L. 1989. High fiber, noncaloric flour substitute for baked foods. Effects of alkaline peroxide treated lignocellulose on dough properties. Cereal Chem. 66(3):205-209.
Jeffers, H. C. and Rubenthaler, G. L. 1978. High yielding European wheats - determination of pastry end-use properties. Bakers' Digest. 52(1):39-43.
Johansson, E. and Svensson G. 1995. Contribution of the high molecular weight glutenin subunit 21* to breadmaking quality of Swedish wheats. Cereal Chem. 72(3):287-290.
Johnson, J. A., Shellenberger, J. A, and Swanson, C. O. 1946. Farinograms and mixograms as a means of evaluating flours for specific uses. Cereal Chem. 23(4):388-399.
Johnson, J. A., Swanson, C. O., and Bayfield, E. G. 1943. The correlation of mixograms with baking results. Cereal Chem. 20:625.
Joppa, L. R., Bietz, J. A., and McDonald, C. 1975. Development and characteristics of a disomic-1D addition line of durum wheat. Can. J. Genet Cytol. 17:355-363.
Joppa, L. R., Hareland, G. A., and Cantrell, R. G. 1991. Quality characteristics of the Langdon durum dicoccoides chromosome substitution lines. Crop Sci. 31(6):1513-1517.
Joppa, L. R., Josephides, C. M., and Youngs, V. L. 1983. Chromosomal location of genes affecting quality in durum wheat. Pages 297-301 in: Proc. 6th Int. Wheat Genet Symp.: Kyoto, Japan.
Jørgensen, H. 1945. Studies on the Nature of the Bromate Effect. Oxford University Press, London.
Josephides, C. M. 1984. Effect of chromosome 1B on quality and agronomic characteristics of durum wheat, Triticum turgidum L. var. durum. Dissertation Abstr Intern, B. 45(4):1083.
Josephides, C. M., Joppa, L. R., and Youngs, V. L. 1987. Effect of chromosome 1B on gluten strength and other characteristics of durum wheat. Crop Sci. 27(2):212-216.
Karababa, E. and Ercan, R. 1995. Bread baking potential and quality of durum wheats. Gida 20(3):153-159.
Kaufman, S. P. and Fennema, O. 1987. Evaluation of sulfhydryl oxidase as a strengthening agent for wheat flour dough. Cereal Chem. 64(3):172-176.

Kerr, C., Hoseney, R. C., and Faubion, J. M. 1993. Mixograph studies. VI. Combined effects of charge(pH), activated double bond compounds, and oxidants on dough mixing properties. Cereal Chem. 70(6):633-636.
Keswara Rao Vadlamani, and Seib, P. A. 1996. Reduced browning in raw oriental noodles by heat and moisture treatment of wheat. Cereal Chem. 73(1):88-95.
Khatkar, B. S., Bell, A. E., and Schofield, J. D. 1996. A comparative study of the inter relationships between mixograph parameters and breadmaking qualities of wheat flours and glutens. J. the Sci. of Food and Agr. 72(1):71 85.
Khattak, S. 1973. An investigation of parameters used for hard red spring wheat quality evaluation. Dissertation Abstr Intern, B. 33(8):3400.
Khattack, S., D'Appolonia, B. L., Banasik, O. J., and Sibbit, L. D. 1974. Quality tests for the evaluation of hard red spring wheat. Bakers' Digest. 48(4):50-55.
Kilborn, R.H. and Tipples, K.H. 1972. Factors affecting mechanical dough development. III. Mechanical efficiency of laboratory dough mixers. Cereal Chem. 50(1):50-69.
Kilborn, R. H. and Tipples, K. H. 1981. Canadian Test Baking Procedures. I. GRL Remix method and variations. Cereal Foods World 26(11):624-627.
Kim, C. S., Chang, H. G., Hah, D. M., Yoon, J. O., and Shin, H. S. 1984. [Relationship between mixograph properties and bread quality of Korean wheat cultivars, and breeding lines.] Korean J. Food Sci and Techn. 16(2):223-227.
Knackstedt, M. A., Sears, R. G., Rogers, D. E., and Lookhart, G. L. 1994. Effects of T2BS.2RL Wheat - Rye translocation on breadmaking quality in wheat. Crop Sci. 34(4):1066-1070.
Koh, B. K. and Hoseney, R. C. 1994. Methoxyhydroquinone in wheat flour. Cereal Chem. 71(4):311-314.
Kosmolak, F. G. and Baker, R. J. 1979. Early generation screening for baking potential. Canadian J. Plant Sci. 59(1):21-26.
Kosmolak, F. G. and Crowle, W. L. 1980. An effect of nitrogen fertilization on the agronomic traits and dough mixing strength of five Canadian hard red spring wheat cultivars. Canadian J. Plant Sci. 60(4):1071-1076.
Kosmolak, F. G. and Dyck, P. L. 1981. Milling and baking qualities of ten spring wheat cultivars from the People's Republic of China. Cereal Chem. 58(3):246-247.
Kosmolak, F. G., Larson, R. I., and McKenzie, H. 1980. Milling and baking quality of Rescue-Cadet reciprocal substitution lines. Canadian J. Plant Sci. 60(4):1333-1341.
Kovacs, M. I. P., Dahlke, G., and Noll, J. S. 1994. Gluten viscoelasticity: its usefulness in the Canadian durum wheat breeding program. J. Cereal Sci. 19(3):251-257.
Kovacs, M. I. P., Howes, N. K., Leisle, D., and Skerritt, J. H. 1993. The effect of high Mr glutenin subunit composition on the results from tests used to predict durum wheat quality. J. Cereal Sci. 18(1):43-51.
Kovacs, M. I. P., Howes, N. K., Leisle, D., and Zawistowski, J. 1995. Effect of two different low molecular weight glutenin subunits on durum wheat pasta quality parameters. Cereal Chem. 72(1):85-87.
Kovacs, M. I. P., Noll, J. S., Dahlke, G., and Leisle, D. 1995. Pasta viscoelasticity: its usefulness in the Canadian durum wheat breeding program. J. Cereal Sci. 22(2):115-121.
Kulp, K., Roewe-Smith, P., and Lorenz, K. 1983. Preharvest sprouting of winter wheat. I. Rheological properties of flours and physicochemical characteristics of starches. Cereal Chem. 60(5):355-359.
Labuschange, M. T., Coetzee, M. C. B. and VanDeventer, C. S. 1996. Biscuit-making quality prediction using heritability estimates and correlations. J. Sci. of Food and Agr. 70(1):25-28.
Lang, C. E., Neises, E.K., and Walker, C. E. 1992. Effects of additives on flour water dough mixograms. Cereal Chem. 69(6):587-591.
Lawrence, G. J., MacRitchie, F., and Wrigley, F. 1988. Dough and baking quality of wheat lines deficient in glutenin subunits controlled by the Glu-A1, Glu-B1 and Glu-D1 loci. J. Cereal Sci. 7(2):109-112.
Lee, C. H., Lee, H. D., Kwon, O. H., and Chang, H. G. 1984. Milling properties of Australian wheats and physicochemical properties of the flours. J. the Korean Agricultural Chemical Society. 27(1):21-28.
Lee, J. W. and MacRitchie, F. 1971. The effect of gluten protein fractions on dough properties. Cereal Chem. 48(6):620-625.
Le-Grys, G. A. 1989. Dynamic rheological properties of gluten and gluten subfractions. Pages 115-119 in: Preceedings of Trends in food science Symposium. Singapore Institute of Food Sci. and Techn.: Singapore.
Leung, H. K., Magnuson, J. A., and Bruinsma, B. L. 1983. Water binding of wheat flour doughs and breads as studied by deuteron relaxation. J. Food Sci. 48(1):95-99
Li, A. and Walker, C. E. 1992. Dough temperature changes during mixing in a mixograph. Cereal Chem. 69(6):681-683.
Liu, C. Y., Rathjen AJ, Shepherd KW, Gras PW, Giles LC. 1995. Grain quality and yield characteristics of D genome disomic substitution lines in Langdon (Triticum turgidum var. durum). Plant Breeding 114(1):34-39.

Liu, C. Y, Shepherd, K. W., and Gras P. W. 1994. Grain yield and quality characteristics of chromosome 1D and 1B substitution lines in durum wheat and their F2 derived progeny lines. I. Comparisons among the tetraploid phenotypes. J. Cereal Sci. 20(1):23-32.

Liu, C. Y, Shepherd, K. W., and Gras P. W. 1994. Grain yield and quality characteristics of chromosome 1D and 1B substitution lines in durum wheat and their F2 derived progeny lines. II. Preliminary comparisons with normal durum and bread wheats. J. Cereal Sci. 20(3):227-234.

Lookhart, G. L., Martin, M. L., Mosleth, E., Uhlen, A. K., and Hoseney, R. C. 1993. Comparison of high molecular weight subunits of glutenin and baking performance of flours varying in bread making quality. Lebensmittel Wissenschaft und Technologie 26(4):301-306.

Lorenz, K. 1974. Mixogram characteristics as affected by varying atmospheric pressures. Cereal Sci Today. 19(8):322-324, 346.

Lorenz, K., Welsh, J., Normann, R., and Maga, J. 1972. Comparative mixing and baking properties of wheat and triticale flours. Cereal Chem. 49(2):187-193.

Lukow, O. M. 1991. Screening of bread wheats for milling and baking quality a Canadian perspective. Cereal Foods World 36(6):497-501.

Lukow, O. M. and Hussain, A. 1995. Protein quantity and quality effects on mixograph parameters. Cereal Foods World 40(9):668-669 - abstract #177.

MacRitchie, F. 1987. Evaluation of contributions from wheat protein fractions to dough mixing and breadmaking. J. Cereal Sci. 6(3):259-268.

MacRitchie, F., Kasarda, D. D, and Kuzmicky, D. D. 1991. Characterization of wheat protein fractions differing in contributions to breadmaking quality. Cereal Chem. 68(2):122-130.

Mahdi, J. G. and Dawoud, H. M. 1985. The combined effect of fats and oxidants on dough rheological properties. Iraqui J. Agricultural Sci. 3(4):73-80.

Mahdi, J. G. H. and Dawoud, H. M. 1986. The combined effect of surfactants and oxidants on dough rheology. Iraqui J. Agricultural Sci. 4(2):37-48.

Malloch, J. G. 1938. Some results with a new recording mixer for use with small samples. Cereal Chem. 15(4):423-438.

Mani, K., Eliasson, A. C., Lindahl, L., and Traegardh, C. 1992. Rheological properties and breadmaking quality of wheat flour doughs made with different dough mixers. Cereal Chem. 69(2):222-225.

Marais, G. F. 1979. Prediction of and bases for quality in three hard red spring wheat crosses. Dissertation Abstr. Intern., B. 40(4):1463.

Marais, G. F. and D'Appolonia, B. L. 1981. Factors contributing to baking quality differences in hard red spring wheat. II. Bases for different mixing properties. Cereal Chem. 58(5):448-453.

Matthews, R. H. 1970. Starch gelatinization and some physical properties of selected wheat flours. Cereal Sci Today. 15(3):78-80.

Matsuo, R. R., Dexter, J. E., Kosmolak, F. G., and Leisle, D. 1982. Statistical evaluation of tests for assessing spaghetti-making quality of durum wheat. Cereal Chem. 59(3):222-228.

Matsuo, R. R. and Irvine, G. N. 1970. Effect of gluten on the cooking quality of spaghetti. Cereal Chem. 47(2):173-180.

McGaughey, W. H., Dicke, E. B., Finney, K. F., Bolte, L. C., and Shogren, M. D. 1980. Spores in dockage and mill fractions of wheat treated with Bacillus thuringiensis. J. Economic Entomology. 73(6):775-778.

McGuire, C. F. and Lebsock, K. L. 1972. Grain and flour quality factors of spring wheat treated with dicamba and RH 539. Crop Sci. 12(4):456-459.

Mehdi, V. 1973. Correlation between properties of mixograms of flour and unsifted wholewheat meal in Indian wheats. Bulletin of Grain Techn. 11(2):166-168.

Mehdi, V., Singh, D., and Abrol, Y. P. 1971. Mixograph studies on wheat varieties. Bulletin of Grain Techn. 9(4):235-241.

Miki, E., Matsumoto, S., and Yonezawa, D. 1982. Effects of sodium chloride and pH on the rheological properties of synthetic flour dough. J. Japanese Society of Food Sci and Techn. 29(6):353-358.

Miller, B. S., Hays, B., and Johnson, J. A. 1956. Correlation of farinograph, mixograph, sedimentation and baking data for hard red winter wheat flour samples varying widely in quality. Cereal Chem. 33(5):277-289.

Miller, B. S. and Johnson, J. A. 1954. A review of methods for determining the quality of wheat and flour for breadmaking. Kans. Agr. Expt. Station Bulletin. #76. April 1954.

Miller, H. and Fowler, D. B. 1971. Centrifuge absorption and protein content as indices of wheat quality. Canadian J. Plant Sci. 51(3):219-227.

Mohler, I. and Hyza, V. 1992. Mixographic evaluation of Central European wheats. Rostlinna Vyroba, 38(9/10):733-738.

Muller, G. 1936. Der heutige Stand der Mehlqualitätsbewertung mittels physikalischer Mebverfahren. Zeitschrift für das gesamte Getreide-, Mühlen- und Bäckereiwesen 23:104-116.

Muller, H. G. 1968. Aspects of dough rheology. Pages 181-196 in: Rheology and Texture of Foodstuffs. Monograph 27. Soc. Chem. Ind.: London.
Munoz-Betancourt, D. 1978. Bulk hybrid prediction of line performance for quality characteristics in spring wheat. Dissertation Abstracts International, B. 38(7):2987.
Nagi, H. P. S., Pal-Singh, R., Sehgal, K. L., and Sekhon, K. S. 1984. Studies on the milling, rheological and baking characteristics of triticale and wheat blends. J. Food Sci and Techn., India. 21(6):364-367, 12.
Navickis, L. L. 1987. Corn flour addition to wheat flour doughs - effect on rheological properties. Cereal Chem. 64(5):307-310.
Navickis, L. L, Butterfield, R. O, and Nelsen, T. C. 1989. A modified electronic torsion sensor for a 10 gram mixograph with computerized data acquisition and analysis. Cereal Chem. 66(4):350-352.
Navickis, L. L., Rubenthaler, G. S., Nelson, T. C., and Butterfield, R. O. 1990. Evaluating mixogram parameters by electronic torque sensing. Cereal Foods World 35(5):493-496.
Neufeld, K. and Walker, C. E. 1990. Evaluation of commercial wheat gluten using the mixograph. Cereal Foods World. 35(7):667-669.
Oh, N. H. 1985. Oriental dry noodles: measurement of noodle texture, effects of processing variables and flour properties on noodle quality, and determination of optimum absorption of noodle dough. Dissertation Abstr. Intern., B. 45(8):2383.
Oh, N. H., Seib, P. A., Finney, K. F., and Pomeranz, Y. 1986. Noodles. V. Determination of optimum water absorption of flour to prepare oriental noodles. Cereal Chem. 63(2):93-96.
Okezie, B. O. and Dobo, S. B. 1980. Rheological characteristics of winged bean composite flours. Bakers' Digest. 54(1):35-41.
Ovadia, D. Z. 1994. Mixograms and camels' humps. National Notes 1(3):2-4.
Pal-Singh, R., Sehgal, K. L., Saxena, A. K., Sekhon, K. S., and Gill, K. S. 1983. Physico-chemical, rheological and baking characteristics of some promising strains of wheat. J. Research. Punjab Agricultural Univ. 20(4):403-410.
Parades-Lopez, O. and Bushuk, W. 1983. Development and undevelopment of wheat dough by mixing: Microscopic structure and its relation to breadmaking quality. Cereal Chem. 60(1):24-26.
Paredes-Lopez, O. and Covarrubias-Alvarez, M. M. 1984. Influence of gamma radiation on the rheological and functional properties of bread wheats. J. Food Techn. 19(2):225-231.
Paredes-Lopez, O., Covarrubias-Alvarez, M. M., and Barquin-Carmona, J. 1985. Influence of nitrogen fertilization on the physicochemical and functional properties of bread wheats. Cereal Chem. 62(6):427-430.
Pena, R. J., Amaya, A., Rajaram, S., and Mujeeb-Kazi, A. 1990. Variation in quality characteristics associated with some spring 1B 1R translocation wheats. J. Cereal Sci. 12(2):105-112.
Penner, G. A., Kerber, E. R., Larter, E. N., and Lukow, O. M. 1988. Effects of chromosome 7D of Triticum aestivum Canthatch and of four varieties of Triticum tauschii on milling and baking quality. Canadian J. Plant Sci. 68(4):995-1002.
Preston, K. R. and Tipples, K. H. 1980. Effects of acid-soluble and acid-insoluble gluten proteins on the rheological and baking properties of wheat flours. Cereal Chem. 57(5):314-320.
Primard, S., Graybosch, R., Peterson, C. J., and Lee, J. H. 1991. Relationships between gluten protein composition and quality characteristics in four populations of high protein, hard red winter wheat. Cereal Chem. 68(3):305-312.
Pomeranz, Y., Bolling, H., Weipert, D., and Zwingelberg, H. 1984. Beurteilung deutscher Weizensorten mit Hilfe des mixographen. Mühle + Mischfuttertechnik 121:307-308;310.
Pomeranz, Y., Zwingelberg, H., and Weipert, D. 1983. Der mixographeine Methode zur Beurteilung der Qualität von deutschen Weizensorten?. Mühle + Mischfuttertechnik 121:530-541.
Pon, C. R., Lukow, O. M., and Buckley, D. J. 1989. A multichannel, computer based system for analyzing dough rheology. J. Texture Studies 19(4):343-360.
Pshenishnyuk, G. F., Kozlov, G. F., and Chmyr', A. D. 1982. Specific work required for mixing wheat dough. Khlebopekarnaya i Konditerskaya Promyshlennost'. No. 1, 31-34
Pshenishnyuk, G. F., Kozlov, G. F., and Chmyr', A. D. 1981. Energy requirement for kneading wheat dough. Izvestiya Vysshikh Uchebnykh Zavedenii, Pishchevaya Tekhnologiya. No. 3, 64-67.
Qarooni, J., Posner, E. S. and Ponte, J. G. Jr. 1993. Production of pita bread with hard white and other U.S. wheats. Lebens.-Wiss. u_Technol. 26(2):93-99.
Quick, J. S. and Donnelly, B. J. 1980. A rapid test for estimating durum wheat gluten quality. Crop Sci. 20:816-818.
Randall, P. G., Manley, M., McGill, A. E. J., and Taylor, J. R. N. 1993. Relationship between high Mr subunits of glutenin of South African wheats and end use quality. J. Cereal Sci. 18(3):251-258.
Rasper, V. F. 1991. Quality evaluation of cereals and cereal products. Pages 595-638. in: Handbook of cereal science and technology K. J. Lorenz and K. Kulp eds. Marcel Dekker: New York, NY

Rath, C. R., Gras, P. W., Wrigley, C. W., and Walker, C. E. 1990. Evaluation of dough properties from two grams of flour using the mixograph principle. Cereal Foods World. 35(6):572-574.
Rhee, C. 1983. A study on rheological properties of dough and whole wheat bread-baking test of wheat variety 'Cho-Kwang'. Korean J. Food Sci and Techn. 15(3):215-219.
Rho, K. L., Seib, P. A., Chung, O. K., and Deyoe, C. W. 1988. Noodles. VII. Investigating the surface firmness of cooked oriental dry noodles made from hard wheat flours. Cereal Chem. 65(4):320-326.
Rogers, D. E. and Hoseney, R. C. 1987. Test to determine the optimum water absorption for saltine cracker doughs. Cereal Chem. 64(6):370-372.
Rubenthaler, G.L. and King, G.E. 1986. Computer Characterization of mixograms and their relationship to baking performance. Pages 131-168 in: Fundamentals of Dough Rheology. H. Farad and J. Faubion, eds. Am. Assoc of Cereal Chem.: St. Paul, MN.
Ruiz, M. and Carrillo, J. M. 1995. Relationships between different prolamin proteins and some quality properties in durum wheat. Plant Breeding 114(1):40-44.
Salovaara, H. and Karjalainen, R. 1987. Spring wheat mixtures in northern crop production: quality characteristics. J. Agricultural Sci in Finland. 59(1):51-55.
Sathe, S. K., Ponte, J. G. Jr., Rangnekar, P. D., and Salunkhe, D. K. 1981. Effects of addition of Great Northern bean flour and protein concentrates on rheological properties of dough and baking quality of bread. Cereal Chem. 58(2):97-100.
Sauer, W. 1976. Early detection of quality characteristics as a basis for effective selection in wheat breeding. II. Evaluation of physical dough properties by the mixogram. Fruehzeitige Erfassung von Qualitaetsmerkmalen als Grundlage fuer eine wirkungsvolle Selektion in der Weizenzuechtung. II. Das Mixogramm als Mass fuer teigphysikalische Kriterien. Muehle × Mischfuttertechnik. 113(33):453-455.
Scarpellini, P., Degli-Angeli, A., and Cirilli, G. 1979. L -Cysteine, technological adjuvant in biscuit production (preliminary study). Industrie Alimentari. 18(11):789-793.
Schroeder, L. F. and Hoseney, R. C. 1978. Mixograph studies. II. Effect of activated double-bond compounds on dough-mixing properties. Cereal Chem. 55(3):348-360.
Sehgal, K. L., Sekhon, K. S., Gupta, S. K., and Gill, K. S. 1982. Quality characteristics of some promising triticale strains of India. J. Food Sci and Techn., India. 19(4):133-136.
Seibel, W. and Stephan, H. 1973. Flour evaluation by rheological methods. Mehlbeurteilung mit rheologischen Methoden. Getreide, Mehl und Brot. 27(6):206-213.
Shelton, D. R. 1990. Digitized processing of mixograph curves. Cereal Foods World. 35(5):486.
Shelke, K. and Walker, C. E. 1990. A water jacketed bowl for temperature control of the mixograph. Cereal Foods World. 35(6):575-577.
Shellenberger, J. A., Pomeranz, Y., Finney, K. F., and Ward, A. B. 1970. Chemical, rheological and breadmaking characteristics of selected varieties of various wheat classes. Bakers' Digest. 44(5):27-31, 34-36.
Sheu, R. Y., Medcalf, D. G., Gilles, K. A., and Sibbitt, L. D. 1967. Effect of biochemical constituents on macaroni quality. I. Differences between hard red spring and durum wheats. J. Sci. Food Agr. 18:237-239.
Shiba, K., Yamada, H., Hara, H., and Okada, K. 1994. Preparation and effect of cell wall hydrolysate from wheat bran on mixing properties of dough. Cereal Chem. 71(3):279-282.
Shiba, K., Negishi, Y., Okada, K., and Nagao, S. 1991. Purification and characterization of lipoxygenase isozymes from wheat germ. Cereal Chem. 68(2):115-122.
Shogren, M. D. 1990. A short history of the mixograph. Cereal Foods World. 35(5):480-482.
Shogren, M. D., Finney, K. F., and Hoseney, R. C. 1969. Functional (breadmaking) and biochemical properties of wheat flour components. I. Solubilizing gluten and flour protein. Cereal Chem. 46(2):93-102.
Shuey, W. C., Maneval, R. D., Crawford, R. D., and Joppa, L. R. 1978. Influence of planting date and crop year on the milling and baking characteristics of conventional height and semidwarf hard red spring wheats. Sci and Edu. Admin., U.S. Dept of Agr. ARM W 4, 17-22.
Shuey, W. C., Maneval, R. D., Watson, C. A., Dick, J. W., and Crawford, R. D. 1977. Extended extraction flour. Bulletin, Assoc. of Operative Millers. October. 3680-3684.
Shuey, W. C., Watson, C. A., Maneval, R. D., and Crawford, R. D. 1977. Comparison of durum semolina and pasta products from various countries. Cereal Foods World. 22(7):278-283.
Sibbitt, L. D. and Harris, R. H. 1957. New quality data on Dakota durums. North Dakota Agr. Expt. Sta., Bimon. Bull. XIX (4):115-118.

Sibbitt, L. D., Scott, G. M., and Harris, R. H. 1956. Milling and macaroni-making quality of four new durums. North Dakota Agr. Expt. Sta., Bimon. Bull. XVIII(3):88-92.
Sidhu, J. S., Nordin, P., and Hoseney, R. C. 1980. Mixograph studies. III. Reaction of fumaric acid with gluten proteins during dough mixing. Cereal Chem. 57(3):159-163.
Singh, N. K., Donovan, R., and MacRitchie, F. 1990. Use of sonication and size exclusion high performance liquid chromatography in the study of wheat flour proteins. II. Relative quantity of glutenin as a measure of breadmaking quality. Cereal Chem. 67(2):161-170.
Singh, N. K, Donovan, G. R, Batey, I. L, and MacRitchie, F. 1990. Use of sonication and size exclusion high performance liquid chromatography in the study of wheat flour proteins. I. Dissolution of total proteins in the absence of reducing agents. Cereal Chem. 67(2):150-161.
Singh, R. P., Singh, G. P., and Bains, G. S. 1978. Baking response of Punjab wheats to proteolytic supplementation. J. Food Sci and Techn., India. 15(6):259-263.
Sokhansanj, S. 1982. Quality of food grains in recirculating hot-air dryers. Pages 253-258, in: Proceedings of the third international drying symposium. Vol. 2
Stearns, M., and Barta, S. 1990. Mixograph standardization/digital data acquisition. Cereal Foods World 35(5):485-488.
Steele, J. L., Brabec, D. L., and Walker, D. E. 1990. Mixograph instrumentation for moving and fixed bowl comparisons of wheat flour performance. Pages 224-234 in: Proc. Food Processing Automation Conference. May 6-8. Lexington, KY.
Stein, I. S., Sears, R. G., Gill, B. S., Hoseney, R. C., and Cox, T. S. 1992. Heterogeneity of the Wichita wheat monosomic set for grain quality and agronomic traits. Crop Sci. 32(3):581-584.
Stein, I. S., Sears, R. G., Hoseney, R. C., Cox, T. S., and Gill, B. S. 1992. Chromosomal location of genes influencing grain protein concentration and mixogram properties in Plainsman V winter wheat. Crop Sci. 32(3):573-580.
Stoeva, I. and Penchev, E. 1992. Evaluation of winter wheat quality by a mixograph at constant and varying doses of water. Rasteniev"dni Nauki 29(7/8):11-18.
Stoeva, I., Kostov, K., Ivanov, P., Penchev, E., Icherenska, N., and Ivanova, I. 1996. Qualitative characteristics of some Bulgarian and introduced winter common wheat varieties. Rasteniev"dni Nauki 33(5):5-11.
Svenson, G. 1984. The mixograph in the breeding for baking quality. Pages 369-378 in: Proceedings from 22nd Nordic Area Congress: Lillehammer.
Swanson, C. O. 1929. The Origin and Development of the Department of Milling Industry. Department of Grain Science and Industry: Manhattan, KS.
Swanson, C. O. 1943. Physical Properties of Dough. Burgess Publishing Co.: Minneapolis, MN.
Swanson, C. O. and Andrews, A. C. 1943. Factors which influence the physical properties of dough. IV. Gluten protein as the main factor affecting the pattern of mixograms. Cereal Chem. 20:61-79.
Swanson, C. O. and Andrews, A. C. 1944. Factors which influence the physical properties of dough. VI. Effect of cysteine and some other substances on mixogram patterns. Cereal Chem. 21(2):140-149.
Swanson, C. O. and Clark, R. J. 1936. Testing flours by the recording dough mixer. The Northwestern Miller 188:458.
Swanson, C. O. and Johnson, J. A. 1943. Description of mixograms. Cereal Chem. 20(1):39-42.
Swanson, C. O. and Working, E. B. 1926. Mechanical modification of dough to make it possible to bake bread with only the fermentation in the pan. Cereal Chem. 3(2):65-83.
Swanson, C. O. and Working, E. B. 1933. Testing the quality of flour by the recording dough mixer. Cereal Chem. 10(1):1-29.
Taha, S A. 1990. Effect of sodium stearoyl-2-lactylate on some quality parameters of pasta made from durum wheat semolina. Cereal Res. Communications 18(4):321-327.
Taha, S. A. 1990. Effect of gamma irradiation at doses of 5 15 kGy on the quality properties of durum wheat semolina. Acta Alimentaria 19(3):281-290.
Taha, S. A., Acs, E., and Sagi, F. 1992. Evaluation of economical pasta products prepared from durum semolina/yellow corn flour/soy flour mixtures. I. Mixing properties, chemical composition and colour components. Acta Alimentaria 21(2):153-162.
Talukdar, B. S. 1974. Quality studies in wheat. Euphytica. 23(1):149-152.
Tipples, K. H., and Kilborn, R. H. 1975. "Unmixing"-the disorientation of developed bread dough by slow speed mixing. Cereal Chem. 52:248.
Ulmer, R. L. 1973. Relationships of endosperm protein fractions from normal and high protein wheats to protein content, lysine content, quality, and nitrogen fertilization. Dissertation Abstr. Intern., B. 34(5):1835.
Uprety, D. C., Bhardwaj, R. B. L., and Abrol, Y. P. 1976. Soil nitrogen fertility levels and wheat grain yield and quality. Bulletin of Grain Techn. 14(2):97-106.

Vanhamel, S., Cleemput, G., Delcour, J. A., Nys, M., and Darius, P. L. 1993. Physicochemical and functional properties of rye nonstarch polysaccharides. IV. The effect of high molecular weight water soluble pentosans on wheat bread quality in a straight dough procedure. Cereal Chem. 70(3):306-311.

Van-Lill, D. and Purchase, J. L. 1995. Directions in breeding for winter wheat yield and quality in South Africa from 1930 to 1990. Euphytica 82(1):79-87.

Van-Lil, D., Purchase, J. L., Smith, M. F., Agenbag, G. A., and de-Villiers, O. T. 1995. Multivariate assessment of environmental effects on hard red winter wheat. II. Canonical correlation and canonical variate analysis of yield, biochemical and bread making characteristics. S. African J. Plant and Soil 12(4):164-169.

Van-Lil, D., Purchase, J. L., Smith, M. F., Agenbag, G. A., and de-Villiers, O. T. 1995. Multivariate assessment of environmental effects on hard red winter wheat. I. Principal components analysis of yield and bread making characteristics. S. African J. Plant and Soil 12(4):158-163.

Venkateswara-Rao, G. and Haridas-Rao, P. 1993. Methods for determining rheological characteristics of doughs: a critical evaluation. J. Food Science and Technology, India 30(2):77-87.

Venkateswara-Rao, G., Indrani, D., and Shurpalekar, S. R. 1985. Guar gum as an additive for improving the bread making quality of wheat flours. J. Food Sci and Techn. India, 22(2):101-104.

Venkateswara-Rao, G., Savithri, G. D., and Indrani, D. 1992. Studies on the use of garlic in bread. J. Food Science and Technology, India 29(3):147-149.

Vasiljevic, S. and Banasik, O. J. 1980. Quality testing methods for durum wheat and its products. Dept of Cereal Chem. and Techn., North Dakota State Univ., Fargo, ND pg 86-91.

Vidal-Quintanar, R. L. and Walker, C. E. 1993. Absorption and rpm effects on mixing parameters as determined by a prototype 2-gram direct-drive recording dough mixer. National Notes 1(2):2-5

Voisey, P. W., and Miller, H. 1970. The Ottawa electronic recording dough mixer. VII. Factors affecting performance and the use of digital recording techniques. Cereal Chem. 44:359-372.

Voisey, P. W., Miller, H., and Kloek, M. 1966. An electronic recording dough mixer. Parts I-IV. Cereal Chem. 43(4):408-419.

Walcott, J. J. 1985. The effect of the Triticum Timopheevi nucleo-cytoplasmic system on the performance of an F1 hybrid wheat. Australian J. Agricultural Research. 36(4):553-557.

Walker, A. E. and Walker, C. E. 1992. Documentation and User Instructions for Mixsmart© Software. National Mfg. Div. TMCO: Lincoln, NE.

Walker, C. E. and Hazelton, J. L. 1994. Pins, pens, bowls: An overview of factors affecting the mixograph. Proceedings of the RACI Cereal Chem. Div. Conference: 10-15 Sept. Ballarat, Victoria, Australia.

Walker, C. E. and Hazelton, J. L. 1994. Calibrating the mixograph. National Notes 1(3):18-20.

Walker, C. E. and Hazelton, J. L. 1996. Back to the basics: Dough rheology tests. Cereal Foods World 41(1):23-28.

Walker, C. E. and Walker, A. E. 1990. Mixograph data acquisition and analysis by personal computer. Cereal Foods World. 35:823. (Abstract).

Wang, S. M., Watts, B. M., Betker, S. E., Lukow, O. M., and Bushuk, W. 1994. A sensory method of dough stickiness measurement. Cereal Foods World 39(11/12):831-834.

Watson, C. A., Shuey, W. C., Crawford, R. D., and Gumbmann, M. R. 1977. Physical dough, baking, and nutritional qualities of straight-grade and extended-extraction flours. Cereal Chem. 54(3):657-664.

Watson, K. S. and Walker, C. E. 1986. The effect of sucrose esters on flour-water dough mixing characteristics. Cereal Chem. 63(1):62-64.

Weak, E. D., Hoseney, R. C., Seib, P. A., and Baig, M. 1977. Mixograph studies. I. Effect of certain compounds on mixing properties. Cereal Chem. 54(4):794-802.

Weegels, L., Orsel, R., Van de Pijpekamp, A. M., Lichtendonk, W. J., Hamer, R. J., and Schofield, J. D. 1995. Functional properties of low Mr wheat proteins. II. Effects on dough properties. J. Cereal Sci. 21(2):117-126.

Weipert, D. 1987. Evaluation of mixing intensity of recording mixers used in studies of dough rheology. Beurteilung der Knetintensitaet der in der Teigrheologie eingesetzten registrierenden Kneter. Muehle Mischfuttertechnik. 124(12):147-151.

Weipert, D. 1990. The benefits of basic rheometry in studying dough rheology. Cereal Chem. 67(4):311-317.

Weipert, D. 1992. Descriptive and fundamental rheometry in a new light. Cereal Foods World 37(1):15-16, 18-20, 22-24.

Welsh, J. R., and Normann, R. M. 1972. Use of the modified Pelshenke test for early generation wheat quality screening. Crop Sci. 12(1):80-81.

Wilkins, P. J. 1977. Rapid estimation of wheat baking quality. Rhodesian J. Agricultural Research. 15(2):215-223.

Wrigley, C. W., Bason, M. L., and Gras, P. W. 1995. Standard units of measurement: Still needed for cereal chemistry. National Notes 2(2):5-7.
Wooding, A. R. 1990. Evaluation of flour quality with respect to test baking and the modification of mixographs. MS Thesis, Kansas State University, Manhattan, KS.
Wooding, A. R. and Walker, C. E. 1992. Comparison of alternative recording mechanisms (mobile vs. fixed-bowl) for the 35- and 10-gram mixographs. Cereal Chem. 69(3):249-253.
Woods, F. C., Bruinsma, B. L., and Kinsella, J. E. 1980. Note on the effects of protease from Saccharomyces carlsbergensis on dough strength. Cereal Chem. 57(4):290-293.
Wootton, M., Weaver, S. W., Gras, P. W., and Wrigley, C. W. 1982. Microbial deterioration of wet gluten and its effects on gluten properties and bread quality. Food Techn. in Australia. 34(5):248, 250-252.
Yamamoto, H, Worthington, S. T., and Hou, G., and Ng, P. K. W. 1996. Rheological properties and baking qualities of selected soft wheats grown in the United States. Cereal Chem. 73(2):215-221
Yang, G., Wehling, R. L., Zeece, M. G., Partridge, J. E., and Shelton, D. R. 1995. Characterization of hard red winter wheat storage proteins by two dimensional electrophoresis and their correlations with selected quality parameters. Cereal Chem. 72(6):568-570.
Youngs, Y. L., Kunerth, W. H., and Crawford, R. D. 1985. Mineral oil added to wheat for dust control: effects on milling and baking quality. Bulletin, Association of Operative Millers. May, 4476-4480.
Zalik, S. and Ostafichuk, M. 1960. Note on a method of appaising mixogram data. Cereal Chem. 37:105.

# APPENDIX II

Mixograph Method

AACC Approved Method 54-40A

# MIXOGRAPH METHOD

Final approval 11-8-95

## Definition

The mixograph measures and records resistance of a dough to mixing. The mixing curve (mixogram) indicates optimum development time (point of minimum mobility), tolerance to overmixing, and other dough characteristics and estimates bake absorption. The mixograph has been used to study the effects of added ingredients on mixing properties, dough rheology, blending, and quality control and for evaluation of hard, soft, and durum wheats.

## Scope

Applicable to wheat flour.

## Apparatus

1. Mixograph with 10-g or 35-g mixing bowl. (National Manufacturing Co., 507 J St., Lincoln, NE 68508-2935). Flanged bowl, improved pen arm, and damping mechanism should be obtained for older 35-g instruments.
2. Blank bowl bottom and gauge for standardization of clearance between revolving pin and bowl bottom.
3. LeRoy pen No. 4 with 1.875-inch reservoir.
4. Template for revolving-pin alignment.
5. Mixing bowls (preferably four).
6. Balance (0.01 g).
7. Timer, Gra-Lab or equivalent.
8. Auto-buret with three-way stopcock and self-zero tip at top.

## Procedure

*Standardization*

Bowl and head pins

1. Exposed length of each bowl and planetary pin should be 3.49 cm (1.375 in.) and 4.0 cm (1.575 in.) for 10- and 35-g models, respectively.
2. When head is in operating position, clearance between tips of planetary pins and bowl bottom should be 0.086 cm (0.034 in.).

Mixing head

1. Head should revolve at 88 $\pm$ 2 rpm.
2. Adjust stationary gear so that face of dough guard and front and rear pins are parallel to front of mixograph base when pins are inserted into pin-alignment template.
3. Center mixing head over bowl by adjusting head-chassis bearings. Adjust bearings so that head moves up and down freely.

Bowl platform

1. Bowl platform should be level.
2. Access to bowl-platform bearings is through hole on underside of mixograph cabinet. If bowl platform does not appear to be essentially friction-free (after removal of spring from slot), remove 3/4-in. nut, which allows bottom Timken bearing and brass spacer to be removed from bottom of cabinet and facilitates removal of bowl platform from top, together with top Timken bearing. Both Timken bearings should be cleaned and lubricated, using plain 1OW oil, before being assembled. Avoid excessive tightening of 3/4-in. nut.

Pen and pen arm

1. Position pen arm on its supporting rod so that when pen is centered on paper, front and back of bowl platform are parallel to horizontal lines of recording paper.
2. Adjust damping-arm stops so that pen starts on bottom line of recording paper and stops on top line.
3. Pen arm should move up and down freely, and counterbalance on pen arm should be adjusted on arm (without pen) to be approximately balanced, falling slowly when released I cm above paper and rising slowly when released 2 cm above paper.
4. When mixogram is being recorded, weight on paper approximately equals weight of pen plus weight of ink (about 6 g).

Spring

1. Length of relaxed spring proper (between extremities of stubs but without slothook or threaded tail), when spring is lying in horizontal position, should be about 22.0 cm.

2. Length of relaxed spring proper plus slothook, when spring is lying in horizontal position, should be 22.7 cm for 10- and 35-g models.

3. Length of spring proper, when hanging vertically, should be 23.1 and 21.4 cm for 10- and 35-g models, respectively.

4. Extensibility of spring, hanging vertically, should be 3.5 $\pm$ 0.1 cm/100 g when several weights of 50-250 g are applied for 10-g model or 1.10 $\pm$ 0.01 cm/100 g when several weights of 100-800 g are applied for 35-g model.

5. When spring is installed, distance between spring stub and fixed, threaded, mounting bracket should be 1.1 cm. However, if total length of relaxed spring proper, lying in horizontal position (item 1), is not 22.0 cm, adjust distance so that length of spring proper plus distance between stub and mounting bracket totals 23.1 cm for 10- and 35-g models.

6. Shortest distance between rear point of attachment of spring (front of support post) and on-center of setting 12, when damping arm is at origin (pen at bottom of recording paper), should be 22.4 cm.

7. Slothook should be in outermost position (slot 12) of spring-tension-index bar.

Damping (10-g model)

1. Damping arm (removable portion at right of bowl platform) should weigh 200 g without movable weights.

2. Two weights (50 g each with set-screw) usually should be set at outermost position on calibrated center of damping arm.

Damping (35-g model)

1. Damping arm should weigh 350 $\pm$ 5 g.

2. Adjust disk of damping mechanism to rotate freely before installing string.

3. When attached, string should extend spring 2.1 cm.

General

1. All bearing points should have trace of play to permit free movement. Lubricate lightly and regularly with nondetergent lOW oil.

2. Some of factors affecting curve width are amount of damping, drag of pen, room temperature, distance of planetary pins from bowl bottom, free-wheelingness of bowl-platform bearings, amount of absorption water, and gluten protein properties.

3. Some of factors affecting curve height are protein content, absorption water, room temperature, distance of planetary pins from bowl bottom, and extensibility, length, and slot location of spring.

4. To remove V-belt, first remove rear pulley. Position V-belt on both pulleys when replacing rear pulley. Do not force V-belt over pulleys.

5. Raise mixing head by lifting mixing head housing (not top plate).

6. Seat bowl properly and lower mixing head completely before starting mixograph motor. Failure to do either will result in bent pins.

*Determination*

1. Determine moisture content of flour as directed in oven method for flour; (Methods **44-15A, -16, -40**). Weigh flour samples (10 or 35 g on 14% moisture basis) to 0.01 g. Keep flour samples in moisture-proof containers.

2. Room temperature should be maintained at 25 $\pm$ 1 $^{\circ}$ (or other suitable constant temperature) 24 hours a day. Equipment, flour, and water should be at equilibrium with room temperature.

3. Following long idle periods, two or three mixograms of well-known standard flour should precede other recordings.

4. Transfer weighed flour to mixograph bowl with aid of camel-hair brush.

5. With tongue depressor (1.5 cm wide with ends squared and beveled) or rubber spatula, move flour between and somewhat past any two bowl pins, creating triangular hole in center of bowl.

6. Before starting each mixogram, determine that ink is flowing freely from pen.

7. Begin each mixogram on major arc and continue for fixed time to facilitate comparing and evaluating mixograms.

8. Dispense absorption water (see Dough absorption below) from automatic pipes into hole in flour. Immediately place bowl in position on mixograph, lower mixing head, and start recording mixogram. During first few seconds of mixing, brush flour particles that may splash on flare of mixing bowl back into bowl. Record sample number, date, bowl number, and other pertinent data on bottom, unlined strip of recording paper.

9. After last mixogram has been recorded, allow recording-paper motor to run for 16 minutes (min) so that several arcs appear beyond tail of last mixograrn, just outside recording-paper opening on left side of mixograph cabinet. Cut paper three to four arcs beyond tail of last mixogram.

10. Allow mixing head to run with towel in place on bowl platform. Dough particles between planetaries and housing will dry and be dislodged onto towel. Bowl bottom and platform must be kept free of flour, dough, or other particles that could raise bowl sufficiently to alter clearance or permit contact between planetary pins and bowl bottom.

11. Efficiency in recording series of mixograms can be greatly improved by following systematic schedule. During 7 or 8 min of recording on mixogram, pertinent information can be recorded on that mixogram; previously mixed dough and bowl can

be soaking in water while another bowl is being cleaned, dried, and brought to room temperature; and a fourth bowl can be readied with flour and its absorption water entered into buret. In this manner, 1 min is required between mixogram recordings.

### *Dough absorption*

To estimate optimum absorption water (14% moisture basis), use equation

$$Y = 1.5X + 43.6,$$

where X = percent flour protein content (14% moisture basis) and Y = percent absorption water. Proper absorption can be determined by comparing curve characteristics with those of flours having optimum absorption. Add more or less water accordingly if another curve must be produced.

### *Interpretation*

Measurements available from mixograms that indicate various dough-mixing characteristics are the fo11owing:

1. Time to maximum height (min), also called peak or point of minimum mobility.
2. Maximum height of curve center or height of curve center at specified time after start of mixing.
3. Angle between ascending and descending portions of curve at peak. Center of curve at peak is taken as apex of angle; sides of angle are lines drawn along center of curves for specified number of minutes (1 min has been suggested) before and after peak is reached. Angles formed by these 1ines and horizontal may be used to further describe curves.
4. Area under Curve. Area is measured with planimeter or personal computer having area integrator software. Duplicate runs made on different days are expected to agree within 5% in area. Area has been found to decrease average of 2 $cm^2$ for each 1 ° rise in temperature above 25 °.
5. See references for other measurements that are useful in particular studies.

## Notes

1. A 2-g direct drive electronic version mixograph is also available. Necessary modifications to this method are included with the instrument.
2. Software, hardware, and instrument modifications are available as a retrofit or can be originally installed on new mixographs. The computerization system automatically collects and analyzes the mixing curve for approximately 40 different properties.

## References


1.Baig, M. M., and Hoseney, R. C. 1977. Effects of mixer speed, dough temperature, and water absorption on flour-water mixograms. Cereal Chem. 54:605.

2 Bruinsma B. L., Anderson, P. D., and Rubenthaler, G. L. 1978. Rapid method to determine quality of wheat whh the mixograph. Cereal Chem. 55:732.

3. Butler, R. J. 1952. A rapid method for mixograrn-area measurement. Trans. Am. Assoc. Cereal Chem. 10:197.

4. Finney, K. F., and Shogren, M. D. 1972. A ten-gram mixograph for determining and predicting functional properties of wheat flour. Bakers Dig. 46(2):32.

5. Finney, K. F., Yamazaki, W. T., Youngs, V. L., and Rubenthaler, G. L. 1987. Quality of hard, soft and durum wheats. Page 677 in: Wheat and Wheat Improvement. E. G. Heyne, ed. Am. Soc. Agron., Madison, Wl.

6. Finney, K. F., and Barmore, M. A. 1945. Opfimum vs. fixed mixing time at various potassium bromate levels in expenmental bread baking. Cereal Chem. 22:244.

7. Gras, P. W., Hibbard, G. E., and Walker, C. E. 1990. Electronic sensing and interpretation of dough properties using a 35-g mixograph. Cereal Foods World 35:568.

8. Kunenh, W. H., and D'Appolonia, B. L. 1985. Use of the mixograph and farinograph in wheat quality evaluation. Page 27 in: Rheology of Wheat Products. H. Faridi, ed. Am. Assoc. Cereal Chem., St. Paul, MN.

9. Lorenz, K. 1974. Mixogram characteristics as affected by varying atmospheric pressures. Cereal Sci. Today 19:322.

10 Rubenthaler, G. L., and King, G. E. 1986. Computer characterization of mixograms and their relationship to baking absorption. Page 131 in: Fundamentals of Dough Rheology. H. Faridi and J. M. Faubion, eds. Am. Assoc. Cereal Chem., St. Paul, MN

11. Weak, E. D., Hoseney, R. C., Seib, P. A., and Baig, M. 1977. Mixograph studies. 1. Effect of certain compounds on mixing properties. Cereal Chem. 54:794.

12. Wooding, A. R., Walker, C. E., and Finney, K. F. 1990. Comparison of alternative recording mechanisms (fixed vs. mobile bowl) for the 35g and lOg mixographs. Cereal Foods World. 35:824.

13. Yamazaki, W. T. 1947. Note on a rapid method for estimation of mixogram area. Cereal Chem. 24:518.

# APPENDIX III

Tables for Moisture Corrected Weights

A)2 gram
B)10 gram
C)35 gram

# 2-gram Mixograph

Absorption, Flour and Water Amount Table

## 2-gram Mixograph: Absorption, Flour and Water Amount Table
## (8.0 - 8.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 8.00 | | | 8.10 | | | 8.20 | | | 8.30 | | | 8.40 | | | 8.50 | | | 8.60 | | | 8.70 | | | 8.80 | | | 8.90 | | | | | | | | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | | | | | | |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | | | | | | |
| 9.00 | 54.9 | 1.89 | 1.21 | 55.1 | 1.89 | 1.21 | 55.2 | 1.89 | 1.21 | 55.4 | 1.89 | 1.22 | 55.5 | 1.89 | 1.22 | 55.6 | 1.89 | 1.22 | 55.8 | 1.89 | 1.23 | 55.9 | 1.89 | 1.23 | 56.1 | 1.89 | 1.23 | 56.2 | 1.89 | 1.23 | | | | | | |
| 9.10 | 55.0 | 1.89 | 1.21 | 55.1 | 1.89 | 1.21 | 55.2 | 1.89 | 1.21 | 55.4 | 1.89 | 1.22 | 55.5 | 1.89 | 1.22 | 55.7 | 1.89 | 1.22 | 55.8 | 1.89 | 1.22 | 55.9 | 1.89 | 1.23 | 56.1 | 1.89 | 1.23 | 56.2 | 1.89 | 1.23 | | | | | | |
| 9.20 | 55.0 | 1.89 | 1.21 | 55.1 | 1.89 | 1.21 | 55.2 | 1.89 | 1.21 | 55.4 | 1.89 | 1.21 | 55.5 | 1.89 | 1.22 | 55.7 | 1.89 | 1.22 | 55.8 | 1.89 | 1.22 | 56.0 | 1.89 | 1.22 | 56.1 | 1.89 | 1.23 | 56.2 | 1.89 | 1.23 | | | | | | |
| 9.30 | 55.0 | 1.90 | 1.20 | 55.1 | 1.90 | 1.21 | 55.3 | 1.90 | 1.21 | 55.4 | 1.90 | 1.21 | 55.5 | 1.90 | 1.21 | 55.7 | 1.90 | 1.22 | 55.8 | 1.90 | 1.22 | 56.0 | 1.90 | 1.22 | 56.1 | 1.90 | 1.23 | 56.3 | 1.90 | 1.23 | | | | | | |
| 9.40 | 55.0 | 1.90 | 1.20 | 55.1 | 1.90 | 1.20 | 55.3 | 1.90 | 1.21 | 55.4 | 1.90 | 1.21 | 55.6 | 1.90 | 1.21 | 55.7 | 1.90 | 1.22 | 55.8 | 1.90 | 1.22 | 56.0 | 1.90 | 1.22 | 56.1 | 1.90 | 1.22 | 56.3 | 1.90 | 1.23 | | | | | | |
| 9.50 | 55.0 | 1.90 | 1.20 | 55.1 | 1.90 | 1.20 | 55.3 | 1.90 | 1.21 | 55.4 | 1.90 | 1.21 | 55.6 | 1.90 | 1.21 | 55.7 | 1.90 | 1.21 | 55.9 | 1.90 | 1.22 | 56.0 | 1.90 | 1.22 | 56.1 | 1.90 | 1.22 | 56.3 | 1.90 | 1.23 | | | | | | |
| 9.60 | 55.0 | 1.90 | 1.20 | 55.2 | 1.90 | 1.20 | 55.3 | 1.90 | 1.20 | 55.4 | 1.90 | 1.21 | 55.6 | 1.90 | 1.21 | 55.7 | 1.90 | 1.21 | 55.9 | 1.90 | 1.21 | 56.0 | 1.90 | 1.22 | 56.2 | 1.90 | 1.22 | 56.3 | 1.90 | 1.22 | | | | | | |
| 9.70 | 55.0 | 1.90 | 1.20 | 55.2 | 1.90 | 1.20 | 55.3 | 1.90 | 1.20 | 55.5 | 1.90 | 1.20 | 55.6 | 1.90 | 1.21 | 55.7 | 1.90 | 1.21 | 55.9 | 1.90 | 1.21 | 56.0 | 1.90 | 1.22 | 56.2 | 1.90 | 1.22 | 56.3 | 1.90 | 1.22 | | | | | | |
| 9.80 | 55.0 | 1.91 | 1.19 | 55.2 | 1.91 | 1.20 | 55.3 | 1.91 | 1.20 | 55.5 | 1.91 | 1.20 | 55.6 | 1.91 | 1.21 | 55.8 | 1.91 | 1.21 | 55.9 | 1.91 | 1.21 | 56.0 | 1.91 | 1.21 | 56.2 | 1.91 | 1.22 | 56.3 | 1.91 | 1.22 | | | | | | |
| 9.90 | 55.1 | 1.91 | 1.19 | 55.2 | 1.91 | 1.19 | 55.3 | 1.91 | 1.20 | 55.5 | 1.91 | 1.20 | 55.6 | 1.91 | 1.20 | 55.8 | 1.91 | 1.21 | 55.9 | 1.91 | 1.21 | 56.1 | 1.91 | 1.21 | 56.2 | 1.91 | 1.21 | 56.3 | 1.91 | 1.22 | | | | | | |
| 10.00 | 55.1 | 1.91 | 1.19 | 55.2 | 1.91 | 1.19 | 55.4 | 1.91 | 1.20 | 55.5 | 1.91 | 1.20 | 55.6 | 1.91 | 1.20 | 55.8 | 1.91 | 1.20 | 55.9 | 1.91 | 1.21 | 56.1 | 1.91 | 1.21 | 56.2 | 1.91 | 1.21 | 56.4 | 1.91 | 1.22 | | | | | | |
| 10.10 | 55.1 | 1.91 | 1.19 | 55.2 | 1.91 | 1.19 | 55.4 | 1.91 | 1.19 | 55.5 | 1.91 | 1.20 | 55.7 | 1.91 | 1.20 | 55.8 | 1.91 | 1.20 | 55.9 | 1.91 | 1.21 | 56.1 | 1.91 | 1.21 | 56.2 | 1.91 | 1.21 | 56.4 | 1.91 | 1.21 | | | | | | |
| 10.20 | 55.1 | 1.92 | 1.19 | 55.2 | 1.92 | 1.19 | 55.4 | 1.92 | 1.19 | 55.5 | 1.92 | 1.20 | 55.7 | 1.92 | 1.20 | 55.8 | 1.92 | 1.20 | 56.0 | 1.92 | 1.20 | 56.1 | 1.92 | 1.21 | 56.2 | 1.92 | 1.21 | 56.4 | 1.92 | 1.21 | | | | | | |
| 10.30 | 55.1 | 1.92 | 1.18 | 55.2 | 1.92 | 1.19 | 55.4 | 1.92 | 1.19 | 55.5 | 1.92 | 1.19 | 55.7 | 1.92 | 1.20 | 55.8 | 1.92 | 1.20 | 56.0 | 1.92 | 1.20 | 56.1 | 1.92 | 1.20 | 56.3 | 1.92 | 1.21 | 56.4 | 1.92 | 1.21 | | | | | | |
| 10.40 | 55.1 | 1.92 | 1.18 | 55.3 | 1.92 | 1.19 | 55.4 | 1.92 | 1.19 | 55.5 | 1.92 | 1.19 | 55.7 | 1.92 | 1.19 | 55.8 | 1.92 | 1.20 | 56.0 | 1.92 | 1.20 | 56.1 | 1.92 | 1.20 | 56.3 | 1.92 | 1.21 | 56.4 | 1.92 | 1.21 | | | | | | |
| 10.50 | 55.1 | 1.92 | 1.18 | 55.3 | 1.92 | 1.18 | 55.4 | 1.92 | 1.19 | 55.6 | 1.92 | 1.19 | 55.7 | 1.92 | 1.19 | 55.9 | 1.92 | 1.20 | 56.0 | 1.92 | 1.20 | 56.1 | 1.92 | 1.20 | 56.3 | 1.92 | 1.20 | 56.4 | 1.92 | 1.21 | | | | | | |
| 10.60 | 55.1 | 1.92 | 1.18 | 55.3 | 1.92 | 1.18 | 55.4 | 1.92 | 1.18 | 55.6 | 1.92 | 1.19 | 55.7 | 1.92 | 1.19 | 55.9 | 1.92 | 1.19 | 56.0 | 1.92 | 1.20 | 56.2 | 1.92 | 1.20 | 56.3 | 1.92 | 1.20 | 56.4 | 1.92 | 1.20 | | | | | | |
| 10.70 | 55.2 | 1.93 | 1.18 | 55.3 | 1.93 | 1.18 | 55.4 | 1.93 | 1.18 | 55.6 | 1.93 | 1.19 | 55.7 | 1.93 | 1.19 | 55.9 | 1.93 | 1.19 | 56.0 | 1.93 | 1.19 | 56.2 | 1.93 | 1.20 | 56.3 | 1.93 | 1.20 | 56.5 | 1.93 | 1.20 | | | | | | |
| 10.80 | 55.2 | 1.93 | 1.18 | 54.7 | 1.93 | 1.17 | 55.5 | 1.93 | 1.18 | 55.6 | 1.93 | 1.18 | 55.7 | 1.93 | 1.19 | 55.9 | 1.93 | 1.19 | 55.4 | 1.93 | 1.18 | 56.2 | 1.93 | 1.20 | 56.3 | 1.93 | 1.20 | 56.5 | 1.93 | 1.20 | | | | | | |
| 10.90 | 55.2 | 1.93 | 1.17 | 55.3 | 1.93 | 1.18 | 55.5 | 1.93 | 1.18 | 55.6 | 1.93 | 1.18 | 55.8 | 1.93 | 1.18 | 55.9 | 1.93 | 1.19 | 56.1 | 1.93 | 1.19 | 56.2 | 1.93 | 1.19 | 56.3 | 1.93 | 1.20 | 56.5 | 1.93 | 1.20 | | | | | | |
| 11.00 | 55.2 | 1.93 | 1.17 | 55.3 | 1.93 | 1.17 | 55.5 | 1.93 | 1.18 | 55.6 | 1.93 | 1.18 | 55.8 | 1.93 | 1.18 | 55.9 | 1.93 | 1.19 | 56.1 | 1.93 | 1.19 | 56.2 | 1.93 | 1.19 | 56.4 | 1.93 | 1.19 | 56.5 | 1.93 | 1.20 | | | | | | |
| 11.10 | 55.2 | 1.93 | 1.17 | 55.4 | 1.93 | 1.17 | 55.5 | 1.93 | 1.18 | 55.6 | 1.93 | 1.18 | 55.8 | 1.93 | 1.18 | 55.9 | 1.93 | 1.18 | 56.1 | 1.93 | 1.19 | 56.2 | 1.93 | 1.19 | 56.4 | 1.93 | 1.19 | 56.5 | 1.93 | 1.20 | | | | | | |
| 11.20 | 55.2 | 1.94 | 1.17 | 55.4 | 1.94 | 1.17 | 55.5 | 1.94 | 1.17 | 55.7 | 1.94 | 1.18 | 55.8 | 1.94 | 1.18 | 55.9 | 1.94 | 1.18 | 56.1 | 1.94 | 1.18 | 56.2 | 1.94 | 1.19 | 56.4 | 1.94 | 1.19 | 56.5 | 1.94 | 1.19 | | | | | | |
| 11.30 | 55.2 | 1.94 | 1.17 | 55.4 | 1.94 | 1.17 | 55.5 | 1.94 | 1.17 | 55.7 | 1.94 | 1.17 | 55.8 | 1.94 | 1.18 | 56.0 | 1.94 | 1.18 | 56.1 | 1.94 | 1.18 | 56.3 | 1.94 | 1.19 | 56.4 | 1.94 | 1.19 | 56.5 | 1.94 | 1.19 | | | | | | |
| 11.40 | 55.2 | 1.94 | 1.16 | 55.4 | 1.94 | 1.17 | 55.5 | 1.94 | 1.17 | 55.7 | 1.94 | 1.17 | 55.8 | 1.94 | 1.18 | 56.0 | 1.94 | 1.18 | 56.1 | 1.94 | 1.18 | 56.3 | 1.94 | 1.18 | 56.4 | 1.94 | 1.19 | 56.6 | 1.94 | 1.19 | | | | | | |
| 11.50 | 55.3 | 1.94 | 1.16 | 55.4 | 1.94 | 1.16 | 55.6 | 1.94 | 1.17 | 55.7 | 1.94 | 1.17 | 55.8 | 1.94 | 1.17 | 56.0 | 1.94 | 1.18 | 56.1 | 1.94 | 1.18 | 56.3 | 1.94 | 1.18 | 56.4 | 1.94 | 1.19 | 56.6 | 1.94 | 1.19 | | | | | | |
| 11.60 | 55.3 | 1.95 | 1.16 | 55.4 | 1.95 | 1.16 | 55.6 | 1.95 | 1.17 | 55.7 | 1.95 | 1.17 | 55.9 | 1.95 | 1.17 | 56.0 | 1.95 | 1.17 | 56.1 | 1.95 | 1.18 | 56.3 | 1.95 | 1.18 | 56.4 | 1.95 | 1.18 | 56.6 | 1.95 | 1.19 | | | | | | |
| 11.70 | 55.3 | 1.95 | 1.16 | 55.4 | 1.95 | 1.16 | 55.6 | 1.95 | 1.16 | 55.7 | 1.95 | 1.17 | 55.9 | 1.95 | 1.17 | 56.0 | 1.95 | 1.17 | 56.2 | 1.95 | 1.18 | 56.3 | 1.95 | 1.18 | 56.5 | 1.95 | 1.18 | 56.6 | 1.95 | 1.18 | | | | | | |
| 11.80 | 55.3 | 1.95 | 1.16 | 55.4 | 1.95 | 1.16 | 55.6 | 1.95 | 1.16 | 55.7 | 1.95 | 1.16 | 55.9 | 1.95 | 1.17 | 56.0 | 1.95 | 1.17 | 56.2 | 1.95 | 1.17 | 56.3 | 1.95 | 1.18 | 56.5 | 1.95 | 1.18 | 56.6 | 1.95 | 1.18 | | | | | | |
| 11.90 | 55.3 | 1.95 | 1.15 | 55.5 | 1.95 | 1.16 | 55.6 | 1.95 | 1.16 | 55.8 | 1.95 | 1.16 | 55.9 | 1.95 | 1.17 | 56.0 | 1.95 | 1.17 | 56.2 | 1.95 | 1.17 | 56.3 | 1.95 | 1.17 | 56.5 | 1.95 | 1.18 | 56.6 | 1.95 | 1.18 | | | | | | |
| 12.00 | 55.3 | 1.95 | 1.15 | 55.5 | 1.95 | 1.15 | 55.6 | 1.95 | 1.16 | 55.8 | 1.95 | 1.16 | 55.9 | 1.95 | 1.16 | 56.1 | 1.95 | 1.17 | 56.2 | 1.95 | 1.17 | 56.4 | 1.95 | 1.17 | 56.5 | 1.95 | 1.18 | 56.6 | 1.95 | 1.18 | | | | | | |
| 12.10 | 55.3 | 1.96 | 1.15 | 55.5 | 1.96 | 1.15 | 55.6 | 1.96 | 1.16 | 55.8 | 1.96 | 1.16 | 55.9 | 1.96 | 1.16 | 56.1 | 1.96 | 1.16 | 56.2 | 1.96 | 1.17 | 56.4 | 1.96 | 1.17 | 56.5 | 1.96 | 1.17 | 56.7 | 1.96 | 1.18 | | | | | | |
| 12.30 | 55.4 | 1.96 | 1.15 | 55.5 | 1.96 | 1.15 | 55.7 | 1.96 | 1.15 | 55.8 | 1.96 | 1.15 | 56.0 | 1.96 | 1.16 | 56.1 | 1.96 | 1.16 | 56.2 | 1.96 | 1.16 | 56.4 | 1.96 | 1.17 | 56.5 | 1.96 | 1.17 | 56.7 | 1.96 | 1.17 | | | | | | |
| 12.30 | 55.4 | 1.96 | 1.15 | 55.5 | 1.96 | 1.15 | 55.7 | 1.96 | 1.15 | 55.8 | 1.96 | 1.15 | 56.0 | 1.96 | 1.16 | 56.1 | 1.96 | 1.16 | 56.2 | 1.96 | 1.16 | 56.4 | 1.96 | 1.17 | 56.5 | 1.96 | 1.17 | 56.7 | 1.96 | 1.17 | | | | | | |
| 12.40 | 55.4 | 1.96 | 1.14 | 55.5 | 1.96 | 1.15 | 55.7 | 1.96 | 1.15 | 55.8 | 1.96 | 1.15 | 56.0 | 1.96 | 1.16 | 56.1 | 1.96 | 1.16 | 56.3 | 1.96 | 1.16 | 56.4 | 1.96 | 1.16 | 56.6 | 1.96 | 1.17 | 56.7 | 1.96 | 1.17 | | | | | | |
| 12.50 | 55.4 | 1.97 | 1.14 | 55.5 | 1.97 | 1.15 | 55.7 | 1.97 | 1.15 | 55.8 | 1.97 | 1.15 | 56.0 | 1.97 | 1.15 | 56.1 | 1.97 | 1.16 | 56.3 | 1.97 | 1.16 | 56.4 | 1.97 | 1.16 | 56.6 | 1.97 | 1.17 | 56.7 | 1.97 | 1.17 | | | | | | |
| 12.60 | 55.4 | 1.97 | 1.14 | 55.6 | 1.97 | 1.14 | 55.7 | 1.97 | 1.15 | 55.9 | 1.97 | 1.15 | 56.0 | 1.97 | 1.15 | 56.1 | 1.97 | 1.15 | 56.3 | 1.97 | 1.16 | 56.4 | 1.97 | 1.16 | 56.6 | 1.97 | 1.16 | 56.7 | 1.97 | 1.17 | | | | | | |
| 12.70 | 55.4 | 1.97 | 1.14 | 55.6 | 1.97 | 1.14 | 55.7 | 1.97 | 1.14 | 55.9 | 1.97 | 1.15 | 56.0 | 1.97 | 1.15 | 56.2 | 1.97 | 1.15 | 56.3 | 1.97 | 1.16 | 56.5 | 1.97 | 1.16 | 56.6 | 1.97 | 1.16 | 56.8 | 1.97 | 1.16 | | | | | | |
| 12.80 | 55.4 | 1.97 | 1.14 | 55.6 | 1.97 | 1.14 | 55.7 | 1.97 | 1.14 | 55.9 | 1.97 | 1.15 | 56.0 | 1.97 | 1.15 | 56.2 | 1.97 | 1.15 | 56.3 | 1.97 | 1.15 | 56.5 | 1.97 | 1.16 | 56.6 | 1.97 | 1.16 | 56.8 | 1.97 | 1.16 | | | | | | |
| 12.90 | 55.4 | 1.97 | 1.13 | 55.6 | 1.97 | 1.14 | 55.7 | 1.97 | 1.14 | 55.9 | 1.97 | 1.14 | 56.0 | 1.97 | 1.15 | 56.2 | 1.97 | 1.15 | 56.3 | 1.97 | 1.15 | 56.5 | 1.97 | 1.15 | 56.6 | 1.97 | 1.16 | 56.8 | 1.97 | 1.16 | | | | | | |
| 13.00 | 55.5 | 1.98 | 1.13 | 55.6 | 1.98 | 1.14 | 55.8 | 1.98 | 1.14 | 55.9 | 1.98 | 1.14 | 56.1 | 1.98 | 1.14 | 56.2 | 1.98 | 1.15 | 56.4 | 1.98 | 1.15 | 56.5 | 1.98 | 1.15 | 56.6 | 1.98 | 1.16 | 56.8 | 1.98 | 1.16 | | | | | | |
| 13.10 | 55.5 | 1.98 | 1.13 | 55.6 | 1.98 | 1.13 | 55.8 | 1.98 | 1.14 | 55.9 | 1.98 | 1.14 | 56.1 | 1.98 | 1.14 | 56.2 | 1.98 | 1.15 | 56.4 | 1.98 | 1.15 | 56.5 | 1.98 | 1.15 | 56.7 | 1.98 | 1.15 | 56.8 | 1.98 | 1.16 | | | | | | |
| 13.20 | 55.5 | 1.98 | 1.13 | 55.6 | 1.98 | 1.13 | 55.8 | 1.98 | 1.13 | 55.9 | 1.98 | 1.14 | 56.1 | 1.98 | 1.14 | 56.2 | 1.98 | 1.14 | 56.4 | 1.98 | 1.15 | 56.5 | 1.98 | 1.15 | 56.7 | 1.98 | 1.15 | 56.8 | 1.98 | 1.15 | | | | | | |
| 13.30 | 55.5 | 1.98 | 1.13 | 55.7 | 1.98 | 1.13 | 55.8 | 1.98 | 1.13 | 55.9 | 1.98 | 1.14 | 56.1 | 1.98 | 1.14 | 56.2 | 1.98 | 1.14 | 56.4 | 1.98 | 1.14 | 56.5 | 1.98 | 1.15 | 56.7 | 1.98 | 1.15 | 56.8 | 1.98 | 1.15 | | | | | | |
| 13.40 | 55.5 | 1.99 | 1.12 | 55.7 | 1.99 | 1.13 | 55.8 | 1.99 | 1.13 | 56.0 | 1.99 | 1.13 | 56.1 | 1.99 | 1.14 | 56.3 | 1.99 | 1.14 | 56.4 | 1.99 | 1.14 | 56.6 | 1.99 | 1.15 | 56.7 | 1.99 | 1.15 | 56.9 | 1.99 | 1.15 | | | | | | |
| 13.50 | 55.5 | 1.99 | 1.12 | 55.7 | 1.99 | 1.13 | 55.8 | 1.99 | 1.13 | 56.0 | 1.99 | 1.13 | 56.1 | 1.99 | 1.13 | 56.3 | 1.99 | 1.14 | 56.4 | 1.99 | 1.14 | 56.6 | 1.99 | 1.14 | 56.7 | 1.99 | 1.15 | 56.9 | 1.99 | 1.15 | | | | | | |
| 13.60 | 55.5 | 1.99 | 1.12 | 55.7 | 1.99 | 1.12 | 55.8 | 1.99 | 1.13 | 56.0 | 1.99 | 1.13 | 56.1 | 1.99 | 1.13 | 56.3 | 1.99 | 1.14 | 56.4 | 1.99 | 1.14 | 56.6 | 1.99 | 1.14 | 56.7 | 1.99 | 1.14 | 56.9 | 1.99 | 1.15 | | | | | | |
| 13.70 | 55.6 | 1.99 | 1.12 | 55.7 | 1.99 | 1.12 | 55.9 | 1.99 | 1.12 | 56.0 | 1.99 | 1.13 | 56.2 | 1.99 | 1.13 | 56.3 | 1.99 | 1.13 | 56.5 | 1.99 | 1.14 | 56.6 | 1.99 | 1.14 | 56.8 | 1.99 | 1.14 | 56.9 | 1.99 | 1.15 | | | | | | |
| 13.80 | 55.6 | 2.00 | 1.12 | 55.7 | 2.00 | 1.12 | 55.9 | 2.00 | 1.12 | 56.0 | 2.00 | 1.13 | 56.2 | 2.00 | 1.13 | 56.3 | 2.00 | 1.13 | 56.5 | 2.00 | 1.13 | 56.6 | 2.00 | 1.14 | 56.8 | 2.00 | 1.14 | 56.9 | 2.00 | 1.14 | | | | | | |
| 13.90 | 55.6 | 2.00 | 1.11 | 55.7 | 2.00 | 1.12 | 55.9 | 2.00 | 1.12 | 56.0 | 2.00 | 1.12 | 56.2 | 2.00 | 1.13 | 56.3 | 2.00 | 1.13 | 56.5 | 2.00 | 1.13 | 56.6 | 2.00 | 1.14 | 56.8 | 2.00 | 1.14 | 56.9 | 2.00 | 1.14 | | | | | | |
| 14.00 | 55.6 | 2.00 | 1.11 | 55.8 | 2.00 | 1.12 | 55.9 | 2.00 | 1.12 | 56.1 | 2.00 | 1.12 | 56.2 | 2.00 | 1.12 | 56.4 | 2.00 | 1.13 | 56.5 | 2.00 | 1.13 | 56.7 | 2.00 | 1.13 | 56.8 | 2.00 | 1.14 | 57.0 | 2.00 | 1.14 | | | | | | |
| 14.10 | 55.6 | 2.00 | 1.11 | 55.8 | 2.00 | 1.11 | 55.9 | 2.00 | 1.12 | 56.1 | 2.00 | 1.12 | 56.2 | 2.00 | 1.12 | 56.4 | 2.00 | 1.12 | 56.5 | 2.00 | 1.13 | 56.7 | 2.00 | 1.13 | 56.8 | 2.00 | 1.13 | 57.0 | 2.00 | 1.14 | | | | | | |
| 14.20 | 55.6 | 2.00 | 1.11 | 55.8 | 2.00 | 1.11 | 55.9 | 2.00 | 1.11 | 56.1 | 2.00 | 1.12 | 56.2 | 2.00 | 1.12 | 56.4 | 2.00 | 1.12 | 56.5 | 2.00 | 1.13 | 56.7 | 2.00 | 1.13 | 56.8 | 2.00 | 1.13 | 57.0 | 2.00 | 1.13 | | | | | | |
| 14.30 | 55.6 | 2.01 | 1.11 | 55.8 | 2.01 | 1.11 | 55.9 | 2.01 | 1.11 | 56.1 | 2.01 | 1.11 | 56.2 | 2.01 | 1.12 | 56.4 | 2.01 | 1.12 | 56.5 | 2.01 | 1.12 | 56.7 | 2.01 | 1.13 | 56.8 | 2.01 | 1.13 | 57.0 | 2.01 | 1.13 | | | | | | |
| 14.40 | 55.7 | 2.01 | 1.10 | 55.8 | 2.01 | 1.11 | 56.0 | 2.01 | 1.11 | 56.1 | 2.01 | 1.11 | 56.3 | 2.01 | 1.12 | 56.4 | 2.01 | 1.12 | 56.6 | 2.01 | 1.12 | 56.7 | 2.01 | 1.12 | 56.9 | 2.01 | 1.13 | 57.0 | 2.01 | 1.13 | | | | | | |
| 14.50 | 55.7 | 2.01 | 1.10 | 55.8 | 2.01 | 1.10 | 56.0 | 2.01 | 1.11 | 56.1 | 2.01 | 1.11 | 56.3 | 2.01 | 1.11 | 56.4 | 2.01 | 1.12 | 56.6 | 2.01 | 1.12 | 56.7 | 2.01 | 1.12 | 56.9 | 2.01 | 1.13 | 57.0 | 2.01 | 1.13 | | | | | | |
| 14.60 | 55.7 | 2.01 | 1.10 | 55.8 | 2.01 | 1.10 | 56.0 | 2.01 | 1.11 | 56.1 | 2.01 | 1.11 | 56.3 | 2.01 | 1.11 | 56.4 | 2.01 | 1.11 | 56.6 | 2.01 | 1.12 | 56.7 | 2.01 | 1.12 | 56.9 | 2.01 | 1.12 | 57.0 | 2.01 | 1.13 | | | | | | |
| 14.70 | 55.7 | 2.02 | 1.10 | 55.8 | 2.02 | 1.10 | 56.0 | 2.02 | 1.10 | 56.2 | 2.02 | 1.11 | 56.3 | 2.02 | 1.11 | 56.5 | 2.02 | 1.11 | 56.6 | 2.02 | 1.12 | 56.8 | 2.02 | 1.12 | 56.9 | 2.02 | 1.12 | 57.1 | 2.02 | 1.12 | | | | | | |
| 14.80 | 55.7 | 2.02 | 1.10 | 55.9 | 2.02 | 1.10 | 56.0 | 2.02 | 1.10 | 56.2 | 2.02 | 1.10 | 56.3 | 2.02 | 1.11 | 56.5 | 2.02 | 1.11 | 56.6 | 2.02 | 1.11 | 56.8 | 2.02 | 1.12 | 56.9 | 2.02 | 1.12 | 57.1 | 2.02 | 1.12 | | | | | | |
| 14.90 | 55.7 | 2.02 | 1.09 | 55.9 | 2.02 | 1.10 | 56.0 | 2.02 | 1.10 | 56.2 | 2.02 | 1.10 | 56.3 | 2.02 | 1.11 | 56.5 | 2.02 | 1.11 | 56.6 | 2.02 | 1.11 | 56.8 | 2.02 | 1.11 | 56.9 | 2.02 | 1.12 | 57.1 | 2.02 | 1.12 | | | | | | |
| 15.00 | 55.7 | 2.02 | 1.09 | 55.9 | 2.02 | 1.09 | 56.0 | 2.02 | 1.10 | 56.2 | 2.02 | 1.10 | 56.3 | 2.02 | 1.10 | 56.5 | 2.02 | 1.11 | 56.7 | 2.02 | 1.11 | 56.8 | 2.02 | 1.11 | 57.0 | 2.02 | 1.12 | 57.1 | 2.02 | 1.12 | | | | | | |
| 15.10 | 55.8 | 2.03 | 1.09 | 55.9 | 2.03 | 1.09 | 56.1 | 2.03 | 1.10 | 56.2 | 2.03 | 1.10 | 56.4 | 2.03 | 1.10 | 56.5 | 2.03 | 1.10 | 56.7 | 2.03 | 1.11 | 56.8 | 2.03 | 1.11 | 57.0 | 2.03 | 1.11 | 57.1 | 2.03 | 1.12 | | | | | | |
| 15.20 | 55.8 | 2.03 | 1.09 | 55.9 | 2.03 | 1.09 | 56.1 | 2.03 | 1.09 | 56.2 | 2.03 | 1.10 | 56.4 | 2.03 | 1.10 | 56.5 | 2.03 | 1.10 | 56.7 | 2.03 | 1.11 | 56.8 | 2.03 | 1.11 | 57.0 | 2.03 | 1.11 | 57.1 | 2.03 | 1.11 | | | | | | |
| 15.30 | 55.8 | 2.03 | 1.08 | 55.9 | 2.03 | 1.09 | 56.1 | 2.03 | 1.09 | 56.2 | 2.03 | 1.09 | 56.4 | 2.03 | 1.10 | 56.5 | 2.03 | 1.10 | 56.7 | 2.03 | 1.10 | 56.9 | 2.03 | 1.11 | 57.0 | 2.03 | 1.11 | 57.2 | 2.03 | 1.11 | | | | | | |
| 15.40 | 55.8 | 2.03 | 1.08 | 56.0 | 2.03 | 1.09 | 56.1 | 2.03 | 1.09 | 56.3 | 2.03 | 1.09 | 56.4 | 2.03 | 1.10 | 56.6 | 2.03 | 1.10 | 56.7 | 2.03 | 1.10 | 56.9 | 2.03 | 1.10 | 57.0 | 2.03 | 1.11 | 57.2 | 2.03 | 1.11 | | | | | | |
| 15.50 | 55.8 | 2.04 | 1.08 | 56.0 | 2.04 | 1.08 | 56.1 | 2.04 | 1.09 | 56.3 | 2.04 | 1.09 | 56.4 | 2.04 | 1.09 | 56.6 | 2.04 | 1.10 | 56.7 | 2.04 | 1.10 | 56.9 | 2.04 | 1.10 | 57.0 | 2.04 | 1.11 | 57.2 | 2.04 | 1.11 | | | | | | |
| 15.60 | 55.8 | 2.04 | 1.08 | 56.0 | 2.04 | 1.08 | 56.1 | 2.04 | 1.08 | 56.3 | 2.04 | 1.09 | 56.4 | 2.04 | 1.09 | 56.6 | 2.04 | 1.09 | 56.7 | 2.04 | 1.10 | 56.9 | 2.04 | 1.10 | 57.1 | 2.04 | 1.10 | 57.2 | 2.04 | 1.11 | | | | | | |
| 15.70 | 55.8 | 2.04 | 1.08 | 56.0 | 2.04 | 1.08 | 56.1 | 2.04 | 1.08 | 56.3 | 2.04 | 1.09 | 56.5 | 2.04 | 1.09 | 56.6 | 2.04 | 1.09 | 56.8 | 2.04 | 1.09 | 56.9 | 2.04 | 1.10 | 57.1 | 2.04 | 1.10 | 57.2 | 2.04 | 1.10 | | | | | | |
| 15.80 | 55.9 | 2.04 | 1.07 | 56.0 | 2.04 | 1.08 | 56.2 | 2.04 | 1.08 | 56.3 | 2.04 | 1.08 | 56.5 | 2.04 | 1.09 | 56.6 | 2.04 | 1.09 | 56.8 | 2.04 | 1.09 | 56.9 | 2.04 | 1.10 | 57.1 | 2.04 | 1.10 | 57.2 | 2.04 | 1.10 | | | | | | |
| 15.90 | 55.9 | 2.05 | 1.07 | 56.0 | 2.05 | 1.08 | 56.2 | 2.05 | 1.08 | 56.3 | 2.05 | 1.08 | 56.5 | 2.05 | 1.08 | 56.6 | 2.05 | 1.09 | 56.8 | 2.05 | 1.09 | 56.9 | 2.05 | 1.09 | 57.1 | 2.05 | 1.10 | 57.3 | 2.05 | 1.10 | | | | | | |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 2.0; Water (ml) = (% Absorption x 2.0 / 100) + (2.0 - sample weight)

## 2-gram Mixograph: Absorption, Flour and Water Amount Table
## (9.0 - 9.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 9.00 | | | 9.10 | | | 9.20 | | | 9.30 | | | 9.40 | | | 9.50 | | | 9.60 | | | 9.70 | | | 9.80 | | | 9.90 | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml |
| 9.00 | 56.4 | 1.89 | 1.24 | 56.5 | 1.89 | 1.24 | 56.6 | 1.89 | 1.24 | 56.8 | 1.89 | 1.25 | 56.9 | 1.89 | 1.25 | 57.1 | 1.89 | 1.25 | 57.2 | 1.89 | 1.25 | 57.4 | 1.89 | 1.26 | 57.5 | 1.89 | 1.26 | 57.6 | 1.89 | 1.26 |
| 9.10 | 56.4 | 1.89 | 1.24 | 56.5 | 1.89 | 1.24 | 56.7 | 1.89 | 1.24 | 56.8 | 1.89 | 1.24 | 56.9 | 1.89 | 1.25 | 57.1 | 1.89 | 1.25 | 57.2 | 1.89 | 1.25 | 57.4 | 1.89 | 1.26 | 57.5 | 1.89 | 1.26 | 57.6 | 1.89 | 1.26 |
| 9.20 | 56.4 | 1.89 | 1.23 | 56.5 | 1.89 | 1.24 | 56.7 | 1.89 | 1.24 | 56.8 | 1.89 | 1.24 | 57.0 | 1.89 | 1.24 | 57.1 | 1.89 | 1.25 | 57.2 | 1.89 | 1.25 | 57.4 | 1.89 | 1.25 | 57.5 | 1.89 | 1.26 | 57.7 | 1.89 | 1.26 |
| 9.30 | 56.4 | 1.90 | 1.23 | 56.5 | 1.90 | 1.23 | 56.7 | 1.90 | 1.24 | 56.8 | 1.90 | 1.24 | 57.0 | 1.90 | 1.24 | 57.1 | 1.90 | 1.25 | 57.3 | 1.90 | 1.25 | 57.4 | 1.90 | 1.25 | 57.5 | 1.90 | 1.25 | 57.7 | 1.90 | 1.26 |
| 9.40 | 56.4 | 1.90 | 1.23 | 56.6 | 1.90 | 1.23 | 56.7 | 1.90 | 1.24 | 56.8 | 1.90 | 1.24 | 57.0 | 1.90 | 1.24 | 57.1 | 1.90 | 1.24 | 57.3 | 1.90 | 1.25 | 57.4 | 1.90 | 1.25 | 57.6 | 1.90 | 1.25 | 57.7 | 1.90 | 1.26 |
| 9.50 | 56.4 | 1.90 | 1.23 | 56.6 | 1.90 | 1.23 | 56.7 | 1.90 | 1.23 | 56.9 | 1.90 | 1.24 | 57.0 | 1.90 | 1.24 | 57.1 | 1.90 | 1.24 | 57.3 | 1.90 | 1.25 | 57.4 | 1.90 | 1.25 | 57.6 | 1.90 | 1.25 | 57.7 | 1.90 | 1.25 |
| 9.60 | 56.4 | 1.90 | 1.23 | 56.6 | 1.90 | 1.23 | 56.7 | 1.90 | 1.23 | 56.9 | 1.90 | 1.23 | 57.0 | 1.90 | 1.24 | 57.2 | 1.90 | 1.24 | 57.3 | 1.90 | 1.24 | 57.4 | 1.90 | 1.25 | 57.6 | 1.90 | 1.25 | 57.7 | 1.90 | 1.25 |
| 9.70 | 56.5 | 1.90 | 1.22 | 56.6 | 1.90 | 1.23 | 56.7 | 1.90 | 1.23 | 56.9 | 1.90 | 1.23 | 57.0 | 1.90 | 1.24 | 57.2 | 1.90 | 1.24 | 57.3 | 1.90 | 1.24 | 57.5 | 1.90 | 1.24 | 57.6 | 1.90 | 1.25 | 57.7 | 1.90 | 1.25 |
| 9.80 | 56.5 | 1.91 | 1.22 | 56.6 | 1.91 | 1.23 | 56.8 | 1.91 | 1.23 | 56.9 | 1.91 | 1.23 | 57.0 | 1.91 | 1.23 | 57.2 | 1.91 | 1.24 | 57.3 | 1.91 | 1.24 | 57.5 | 1.91 | 1.24 | 57.6 | 1.91 | 1.25 | 57.8 | 1.91 | 1.25 |
| 9.90 | 56.5 | 1.91 | 1.22 | 56.6 | 1.91 | 1.22 | 56.8 | 1.91 | 1.23 | 56.9 | 1.91 | 1.23 | 57.1 | 1.91 | 1.23 | 57.2 | 1.91 | 1.24 | 57.3 | 1.91 | 1.24 | 57.5 | 1.91 | 1.24 | 57.6 | 1.91 | 1.24 | 57.8 | 1.91 | 1.25 |
| 10.00 | 56.5 | 1.91 | 1.22 | 56.6 | 1.91 | 1.22 | 56.8 | 1.91 | 1.22 | 56.9 | 1.91 | 1.23 | 57.1 | 1.91 | 1.23 | 57.2 | 1.91 | 1.23 | 57.4 | 1.91 | 1.24 | 57.5 | 1.91 | 1.24 | 57.6 | 1.91 | 1.24 | 57.8 | 1.91 | 1.24 |
| 10.10 | 56.5 | 1.91 | 1.22 | 56.7 | 1.91 | 1.22 | 56.8 | 1.91 | 1.22 | 56.9 | 1.91 | 1.23 | 57.1 | 1.91 | 1.23 | 57.2 | 1.91 | 1.23 | 57.4 | 1.91 | 1.23 | 57.5 | 1.91 | 1.24 | 57.7 | 1.91 | 1.24 | 57.8 | 1.91 | 1.24 |
| 10.20 | 56.5 | 1.92 | 1.22 | 56.7 | 1.92 | 1.22 | 56.8 | 1.92 | 1.22 | 57.0 | 1.92 | 1.22 | 57.1 | 1.92 | 1.23 | 57.2 | 1.92 | 1.23 | 57.4 | 1.92 | 1.23 | 57.5 | 1.92 | 1.24 | 57.7 | 1.92 | 1.24 | 57.8 | 1.92 | 1.24 |
| 10.30 | 56.5 | 1.92 | 1.21 | 56.7 | 1.92 | 1.22 | 56.8 | 1.92 | 1.22 | 57.0 | 1.92 | 1.22 | 57.1 | 1.92 | 1.22 | 57.3 | 1.92 | 1.23 | 57.4 | 1.92 | 1.23 | 57.5 | 1.92 | 1.23 | 57.7 | 1.92 | 1.24 | 57.8 | 1.92 | 1.24 |
| 10.40 | 56.6 | 1.92 | 1.21 | 56.7 | 1.92 | 1.21 | 56.8 | 1.92 | 1.22 | 57.0 | 1.92 | 1.22 | 57.1 | 1.92 | 1.22 | 57.3 | 1.92 | 1.23 | 57.4 | 1.92 | 1.23 | 57.6 | 1.92 | 1.23 | 57.7 | 1.92 | 1.23 | 57.9 | 1.92 | 1.24 |
| 10.50 | 56.6 | 1.92 | 1.21 | 56.7 | 1.92 | 1.21 | 56.9 | 1.92 | 1.22 | 57.0 | 1.92 | 1.22 | 57.1 | 1.92 | 1.22 | 57.3 | 1.92 | 1.22 | 57.4 | 1.92 | 1.23 | 57.6 | 1.92 | 1.23 | 57.7 | 1.92 | 1.23 | 57.9 | 1.92 | 1.24 |
| 10.60 | 56.6 | 1.92 | 1.21 | 56.7 | 1.92 | 1.21 | 56.9 | 1.92 | 1.21 | 57.0 | 1.92 | 1.22 | 57.2 | 1.92 | 1.22 | 57.3 | 1.92 | 1.22 | 57.5 | 1.92 | 1.23 | 57.6 | 1.92 | 1.23 | 57.7 | 1.92 | 1.23 | 57.9 | 1.92 | 1.23 |
| 10.70 | 56.6 | 1.93 | 1.21 | 56.7 | 1.93 | 1.21 | 56.9 | 1.93 | 1.21 | 57.0 | 1.93 | 1.21 | 57.2 | 1.93 | 1.22 | 57.3 | 1.93 | 1.22 | 57.5 | 1.93 | 1.22 | 57.6 | 1.93 | 1.23 | 57.8 | 1.93 | 1.23 | 57.9 | 1.93 | 1.23 |
| 10.80 | 56.6 | 1.93 | 1.20 | 56.2 | 1.93 | 1.19 | 56.9 | 1.93 | 1.21 | 57.0 | 1.93 | 1.21 | 57.2 | 1.93 | 1.22 | 57.3 | 1.93 | 1.22 | 56.9 | 1.93 | 1.21 | 57.6 | 1.93 | 1.22 | 57.8 | 1.93 | 1.23 | 57.9 | 1.93 | 1.23 |
| 10.90 | 56.6 | 1.93 | 1.20 | 56.8 | 1.93 | 1.21 | 56.9 | 1.93 | 1.21 | 57.1 | 1.93 | 1.21 | 57.2 | 1.93 | 1.21 | 57.4 | 1.93 | 1.22 | 57.5 | 1.93 | 1.22 | 57.6 | 1.93 | 1.22 | 57.8 | 1.93 | 1.23 | 57.9 | 1.93 | 1.23 |
| 11.00 | 56.6 | 1.93 | 1.20 | 56.8 | 1.93 | 1.20 | 56.9 | 1.93 | 1.21 | 57.1 | 1.93 | 1.21 | 57.2 | 1.93 | 1.21 | 57.4 | 1.93 | 1.21 | 57.5 | 1.93 | 1.22 | 57.7 | 1.93 | 1.22 | 57.8 | 1.93 | 1.22 | 57.9 | 1.93 | 1.23 |
| 11.10 | 56.7 | 1.93 | 1.20 | 56.8 | 1.93 | 1.20 | 56.9 | 1.93 | 1.20 | 57.1 | 1.93 | 1.21 | 57.2 | 1.93 | 1.21 | 57.4 | 1.93 | 1.21 | 57.5 | 1.93 | 1.22 | 57.7 | 1.93 | 1.22 | 57.8 | 1.93 | 1.22 | 58.0 | 1.93 | 1.22 |
| 11.20 | 56.7 | 1.94 | 1.20 | 56.8 | 1.94 | 1.20 | 57.0 | 1.94 | 1.20 | 57.1 | 1.94 | 1.21 | 57.3 | 1.94 | 1.21 | 57.4 | 1.94 | 1.21 | 57.5 | 1.94 | 1.21 | 57.7 | 1.94 | 1.22 | 57.8 | 1.94 | 1.22 | 58.0 | 1.94 | 1.22 |
| 11.30 | 56.7 | 1.94 | 1.19 | 56.8 | 1.94 | 1.20 | 57.0 | 1.94 | 1.20 | 57.1 | 1.94 | 1.20 | 57.3 | 1.94 | 1.21 | 57.4 | 1.94 | 1.21 | 57.6 | 1.94 | 1.21 | 57.7 | 1.94 | 1.22 | 57.9 | 1.94 | 1.22 | 58.0 | 1.94 | 1.22 |
| 11.40 | 56.7 | 1.94 | 1.19 | 56.8 | 1.94 | 1.20 | 57.0 | 1.94 | 1.20 | 57.1 | 1.94 | 1.20 | 57.3 | 1.94 | 1.20 | 57.4 | 1.94 | 1.21 | 57.6 | 1.94 | 1.21 | 57.7 | 1.94 | 1.21 | 57.9 | 1.94 | 1.22 | 58.0 | 1.94 | 1.22 |
| 11.50 | 56.7 | 1.94 | 1.19 | 56.9 | 1.94 | 1.19 | 57.0 | 1.94 | 1.20 | 57.2 | 1.94 | 1.20 | 57.3 | 1.94 | 1.20 | 57.4 | 1.94 | 1.21 | 57.6 | 1.94 | 1.21 | 57.7 | 1.94 | 1.21 | 57.9 | 1.94 | 1.21 | 58.0 | 1.94 | 1.22 |
| 11.60 | 56.7 | 1.95 | 1.19 | 56.9 | 1.95 | 1.19 | 57.0 | 1.95 | 1.19 | 57.2 | 1.95 | 1.20 | 57.3 | 1.95 | 1.20 | 57.5 | 1.95 | 1.20 | 57.6 | 1.95 | 1.21 | 57.8 | 1.95 | 1.21 | 57.9 | 1.95 | 1.21 | 58.0 | 1.95 | 1.22 |
| 11.70 | 56.7 | 1.95 | 1.19 | 56.9 | 1.95 | 1.19 | 57.0 | 1.95 | 1.19 | 57.2 | 1.95 | 1.20 | 57.3 | 1.95 | 1.20 | 57.5 | 1.95 | 1.20 | 57.6 | 1.95 | 1.20 | 57.8 | 1.95 | 1.21 | 57.9 | 1.95 | 1.21 | 58.1 | 1.95 | 1.21 |
| 11.80 | 56.8 | 1.95 | 1.19 | 56.9 | 1.95 | 1.19 | 57.1 | 1.95 | 1.19 | 57.2 | 1.95 | 1.19 | 57.3 | 1.95 | 1.20 | 57.5 | 1.95 | 1.20 | 57.6 | 1.95 | 1.20 | 57.8 | 1.95 | 1.21 | 57.9 | 1.95 | 1.21 | 58.1 | 1.95 | 1.21 |
| 11.90 | 56.8 | 1.95 | 1.18 | 56.9 | 1.95 | 1.19 | 57.1 | 1.95 | 1.19 | 57.2 | 1.95 | 1.19 | 57.4 | 1.95 | 1.19 | 57.5 | 1.95 | 1.20 | 57.7 | 1.95 | 1.20 | 57.8 | 1.95 | 1.20 | 57.9 | 1.95 | 1.21 | 58.1 | 1.95 | 1.21 |
| 12.00 | 56.8 | 1.95 | 1.18 | 56.9 | 1.95 | 1.18 | 57.1 | 1.95 | 1.19 | 57.2 | 1.95 | 1.19 | 57.4 | 1.95 | 1.19 | 57.5 | 1.95 | 1.20 | 57.7 | 1.95 | 1.20 | 57.8 | 1.95 | 1.20 | 58.0 | 1.95 | 1.20 | 58.1 | 1.95 | 1.21 |
| 12.10 | 56.8 | 1.96 | 1.18 | 57.0 | 1.96 | 1.18 | 57.1 | 1.96 | 1.19 | 57.2 | 1.96 | 1.19 | 57.4 | 1.96 | 1.19 | 57.5 | 1.96 | 1.19 | 57.7 | 1.96 | 1.20 | 57.8 | 1.96 | 1.20 | 58.0 | 1.96 | 1.20 | 58.1 | 1.96 | 1.21 |
| 12.30 | 56.8 | 1.96 | 1.18 | 57.0 | 1.96 | 1.18 | 57.1 | 1.96 | 1.18 | 57.3 | 1.96 | 1.18 | 57.4 | 1.96 | 1.19 | 57.6 | 1.96 | 1.19 | 57.7 | 1.96 | 1.19 | 57.9 | 1.96 | 1.20 | 58.0 | 1.96 | 1.20 | 58.2 | 1.96 | 1.20 |
| 12.30 | 56.8 | 1.96 | 1.18 | 57.0 | 1.96 | 1.18 | 57.1 | 1.96 | 1.18 | 57.3 | 1.96 | 1.18 | 57.4 | 1.96 | 1.19 | 57.6 | 1.96 | 1.19 | 57.7 | 1.96 | 1.19 | 57.9 | 1.96 | 1.20 | 58.0 | 1.96 | 1.20 | 58.2 | 1.96 | 1.20 |
| 12.40 | 56.9 | 1.96 | 1.17 | 57.0 | 1.96 | 1.18 | 57.1 | 1.96 | 1.18 | 57.3 | 1.96 | 1.18 | 57.4 | 1.96 | 1.19 | 57.6 | 1.96 | 1.19 | 57.7 | 1.96 | 1.19 | 57.9 | 1.96 | 1.19 | 58.0 | 1.96 | 1.20 | 58.2 | 1.96 | 1.20 |
| 12.50 | 56.9 | 1.97 | 1.17 | 57.0 | 1.97 | 1.17 | 57.2 | 1.97 | 1.18 | 57.3 | 1.97 | 1.18 | 57.5 | 1.97 | 1.18 | 57.6 | 1.97 | 1.19 | 57.8 | 1.97 | 1.19 | 57.9 | 1.97 | 1.19 | 58.0 | 1.97 | 1.20 | 58.2 | 1.97 | 1.20 |
| 12.60 | 56.9 | 1.97 | 1.17 | 57.0 | 1.97 | 1.17 | 57.2 | 1.97 | 1.18 | 57.3 | 1.97 | 1.18 | 57.5 | 1.97 | 1.18 | 57.6 | 1.97 | 1.18 | 57.8 | 1.97 | 1.19 | 57.9 | 1.97 | 1.19 | 58.1 | 1.97 | 1.19 | 58.2 | 1.97 | 1.20 |
| 12.70 | 56.9 | 1.97 | 1.17 | 57.0 | 1.97 | 1.17 | 57.2 | 1.97 | 1.17 | 57.3 | 1.97 | 1.18 | 57.5 | 1.97 | 1.18 | 57.6 | 1.97 | 1.18 | 57.8 | 1.97 | 1.19 | 57.9 | 1.97 | 1.19 | 58.1 | 1.97 | 1.19 | 58.2 | 1.97 | 1.19 |
| 12.80 | 56.9 | 1.97 | 1.17 | 57.1 | 1.97 | 1.17 | 57.2 | 1.97 | 1.17 | 57.4 | 1.97 | 1.17 | 57.5 | 1.97 | 1.18 | 57.7 | 1.97 | 1.18 | 57.8 | 1.97 | 1.18 | 57.9 | 1.97 | 1.19 | 58.1 | 1.97 | 1.19 | 58.2 | 1.97 | 1.19 |
| 12.90 | 56.9 | 1.97 | 1.16 | 57.1 | 1.97 | 1.17 | 57.2 | 1.97 | 1.17 | 57.4 | 1.97 | 1.17 | 57.5 | 1.97 | 1.18 | 57.7 | 1.97 | 1.18 | 57.8 | 1.97 | 1.18 | 58.0 | 1.97 | 1.18 | 58.1 | 1.97 | 1.19 | 58.3 | 1.97 | 1.19 |
| 13.00 | 56.9 | 1.98 | 1.16 | 57.1 | 1.98 | 1.16 | 57.2 | 1.98 | 1.17 | 57.4 | 1.98 | 1.17 | 57.5 | 1.98 | 1.17 | 57.7 | 1.98 | 1.18 | 57.8 | 1.98 | 1.18 | 58.0 | 1.98 | 1.18 | 58.1 | 1.98 | 1.19 | 58.3 | 1.98 | 1.19 |
| 13.10 | 57.0 | 1.98 | 1.16 | 57.1 | 1.98 | 1.16 | 57.3 | 1.98 | 1.17 | 57.4 | 1.98 | 1.17 | 57.6 | 1.98 | 1.17 | 57.7 | 1.98 | 1.17 | 57.9 | 1.98 | 1.18 | 58.0 | 1.98 | 1.18 | 58.1 | 1.98 | 1.18 | 58.3 | 1.98 | 1.19 |
| 13.20 | 57.0 | 1.98 | 1.16 | 57.1 | 1.98 | 1.16 | 57.3 | 1.98 | 1.16 | 57.4 | 1.98 | 1.17 | 57.6 | 1.98 | 1.17 | 57.7 | 1.98 | 1.17 | 57.9 | 1.98 | 1.18 | 58.0 | 1.98 | 1.18 | 58.2 | 1.98 | 1.18 | 58.3 | 1.98 | 1.18 |
| 13.30 | 57.0 | 1.98 | 1.16 | 57.1 | 1.98 | 1.16 | 57.3 | 1.98 | 1.16 | 57.4 | 1.98 | 1.16 | 57.6 | 1.98 | 1.17 | 57.7 | 1.98 | 1.17 | 57.9 | 1.98 | 1.17 | 58.0 | 1.98 | 1.18 | 58.2 | 1.98 | 1.18 | 58.3 | 1.98 | 1.18 |
| 13.40 | 57.0 | 1.99 | 1.15 | 57.2 | 1.99 | 1.16 | 57.3 | 1.99 | 1.16 | 57.5 | 1.99 | 1.16 | 57.6 | 1.99 | 1.17 | 57.8 | 1.99 | 1.17 | 57.9 | 1.99 | 1.17 | 58.0 | 1.99 | 1.17 | 58.2 | 1.99 | 1.18 | 58.3 | 1.99 | 1.18 |
| 13.50 | 57.0 | 1.99 | 1.15 | 57.2 | 1.99 | 1.15 | 57.3 | 1.99 | 1.16 | 57.5 | 1.99 | 1.16 | 57.6 | 1.99 | 1.16 | 57.8 | 1.99 | 1.17 | 57.9 | 1.99 | 1.17 | 58.1 | 1.99 | 1.17 | 58.2 | 1.99 | 1.18 | 58.4 | 1.99 | 1.18 |
| 13.60 | 57.0 | 1.99 | 1.15 | 57.2 | 1.99 | 1.15 | 57.3 | 1.99 | 1.16 | 57.5 | 1.99 | 1.16 | 57.6 | 1.99 | 1.16 | 57.8 | 1.99 | 1.16 | 57.9 | 1.99 | 1.17 | 58.1 | 1.99 | 1.17 | 58.2 | 1.99 | 1.17 | 58.4 | 1.99 | 1.18 |
| 13.70 | 57.1 | 1.99 | 1.15 | 57.2 | 1.99 | 1.15 | 57.4 | 1.99 | 1.15 | 57.5 | 1.99 | 1.16 | 57.7 | 1.99 | 1.16 | 57.8 | 1.99 | 1.16 | 57.9 | 1.99 | 1.17 | 58.1 | 1.99 | 1.17 | 58.2 | 1.99 | 1.17 | 58.4 | 1.99 | 1.17 |
| 13.80 | 57.1 | 2.00 | 1.15 | 57.2 | 2.00 | 1.15 | 57.4 | 2.00 | 1.15 | 57.5 | 2.00 | 1.15 | 57.7 | 2.00 | 1.16 | 57.8 | 2.00 | 1.16 | 58.0 | 2.00 | 1.16 | 58.1 | 2.00 | 1.17 | 58.3 | 2.00 | 1.17 | 58.4 | 2.00 | 1.17 |
| 13.90 | 57.1 | 2.00 | 1.14 | 57.2 | 2.00 | 1.15 | 57.4 | 2.00 | 1.15 | 57.5 | 2.00 | 1.15 | 57.7 | 2.00 | 1.16 | 57.8 | 2.00 | 1.16 | 58.0 | 2.00 | 1.16 | 58.1 | 2.00 | 1.16 | 58.3 | 2.00 | 1.17 | 58.4 | 2.00 | 1.17 |
| 14.00 | 57.1 | 2.00 | 1.14 | 57.3 | 2.00 | 1.15 | 57.4 | 2.00 | 1.15 | 57.6 | 2.00 | 1.15 | 57.7 | 2.00 | 1.15 | 57.9 | 2.00 | 1.16 | 58.0 | 2.00 | 1.16 | 58.2 | 2.00 | 1.16 | 58.3 | 2.00 | 1.17 | 58.5 | 2.00 | 1.17 |
| 14.10 | 57.1 | 2.00 | 1.14 | 57.3 | 2.00 | 1.14 | 57.4 | 2.00 | 1.15 | 57.6 | 2.00 | 1.15 | 57.7 | 2.00 | 1.15 | 57.9 | 2.00 | 1.16 | 58.0 | 2.00 | 1.16 | 58.2 | 2.00 | 1.16 | 58.3 | 2.00 | 1.16 | 58.5 | 2.00 | 1.17 |
| 14.20 | 57.1 | 2.00 | 1.14 | 57.3 | 2.00 | 1.14 | 57.4 | 2.00 | 1.14 | 57.6 | 2.00 | 1.15 | 57.7 | 2.00 | 1.15 | 57.9 | 2.00 | 1.15 | 58.0 | 2.00 | 1.16 | 58.2 | 2.00 | 1.16 | 58.3 | 2.00 | 1.16 | 58.5 | 2.00 | 1.17 |
| 14.30 | 57.1 | 2.01 | 1.14 | 57.3 | 2.01 | 1.14 | 57.4 | 2.01 | 1.14 | 57.6 | 2.01 | 1.14 | 57.7 | 2.01 | 1.15 | 57.9 | 2.01 | 1.15 | 58.1 | 2.01 | 1.15 | 58.2 | 2.01 | 1.16 | 58.4 | 2.01 | 1.16 | 58.5 | 2.01 | 1.16 |
| 14.40 | 57.2 | 2.01 | 1.13 | 57.3 | 2.01 | 1.14 | 57.5 | 2.01 | 1.14 | 57.6 | 2.01 | 1.14 | 57.8 | 2.01 | 1.15 | 57.9 | 2.01 | 1.15 | 58.1 | 2.01 | 1.15 | 58.2 | 2.01 | 1.16 | 58.4 | 2.01 | 1.16 | 58.5 | 2.01 | 1.16 |
| 14.50 | 57.2 | 2.01 | 1.13 | 57.3 | 2.01 | 1.13 | 57.5 | 2.01 | 1.14 | 57.6 | 2.01 | 1.14 | 57.8 | 2.01 | 1.14 | 57.9 | 2.01 | 1.15 | 58.1 | 2.01 | 1.15 | 58.2 | 2.01 | 1.15 | 58.4 | 2.01 | 1.16 | 58.5 | 2.01 | 1.16 |
| 14.60 | 57.2 | 2.01 | 1.13 | 57.3 | 2.01 | 1.13 | 57.5 | 2.01 | 1.14 | 57.6 | 2.01 | 1.14 | 57.8 | 2.01 | 1.14 | 58.0 | 2.01 | 1.14 | 58.1 | 2.01 | 1.15 | 58.3 | 2.01 | 1.15 | 58.4 | 2.01 | 1.15 | 58.6 | 2.01 | 1.16 |
| 14.70 | 57.2 | 2.02 | 1.13 | 57.4 | 2.02 | 1.13 | 57.5 | 2.02 | 1.13 | 57.7 | 2.02 | 1.14 | 57.8 | 2.02 | 1.14 | 58.0 | 2.02 | 1.14 | 58.1 | 2.02 | 1.15 | 58.3 | 2.02 | 1.15 | 58.4 | 2.02 | 1.15 | 58.6 | 2.02 | 1.16 |
| 14.80 | 57.2 | 2.02 | 1.13 | 57.4 | 2.02 | 1.13 | 57.5 | 2.02 | 1.13 | 57.7 | 2.02 | 1.13 | 57.8 | 2.02 | 1.14 | 58.0 | 2.02 | 1.14 | 58.1 | 2.02 | 1.14 | 58.3 | 2.02 | 1.15 | 58.4 | 2.02 | 1.15 | 58.6 | 2.02 | 1.15 |
| 14.90 | 57.2 | 2.02 | 1.12 | 57.4 | 2.02 | 1.13 | 57.5 | 2.02 | 1.13 | 57.7 | 2.02 | 1.13 | 57.8 | 2.02 | 1.14 | 58.0 | 2.02 | 1.14 | 58.2 | 2.02 | 1.14 | 58.3 | 2.02 | 1.14 | 58.5 | 2.02 | 1.15 | 58.6 | 2.02 | 1.15 |
| 15.00 | 57.3 | 2.02 | 1.12 | 57.4 | 2.02 | 1.12 | 57.6 | 2.02 | 1.13 | 57.7 | 2.02 | 1.13 | 57.9 | 2.02 | 1.13 | 58.0 | 2.02 | 1.14 | 58.2 | 2.02 | 1.14 | 58.3 | 2.02 | 1.14 | 58.5 | 2.02 | 1.15 | 58.6 | 2.02 | 1.15 |
| 15.10 | 57.3 | 2.03 | 1.12 | 57.4 | 2.03 | 1.12 | 57.6 | 2.03 | 1.13 | 57.7 | 2.03 | 1.13 | 57.9 | 2.03 | 1.13 | 58.0 | 2.03 | 1.13 | 58.2 | 2.03 | 1.14 | 58.3 | 2.03 | 1.14 | 58.5 | 2.03 | 1.14 | 58.6 | 2.03 | 1.15 |
| 15.20 | 57.3 | 2.03 | 1.12 | 57.4 | 2.03 | 1.12 | 57.6 | 2.03 | 1.12 | 57.7 | 2.03 | 1.13 | 57.9 | 2.03 | 1.13 | 58.1 | 2.03 | 1.13 | 58.2 | 2.03 | 1.14 | 58.4 | 2.03 | 1.14 | 58.5 | 2.03 | 1.14 | 58.7 | 2.03 | 1.14 |
| 15.30 | 57.3 | 2.03 | 1.12 | 57.5 | 2.03 | 1.12 | 57.6 | 2.03 | 1.12 | 57.8 | 2.03 | 1.12 | 57.9 | 2.03 | 1.13 | 58.1 | 2.03 | 1.13 | 58.2 | 2.03 | 1.13 | 58.4 | 2.03 | 1.14 | 58.5 | 2.03 | 1.14 | 58.7 | 2.03 | 1.14 |
| 15.40 | 57.3 | 2.03 | 1.11 | 57.5 | 2.03 | 1.12 | 57.6 | 2.03 | 1.12 | 57.8 | 2.03 | 1.12 | 57.9 | 2.03 | 1.13 | 58.1 | 2.03 | 1.13 | 58.2 | 2.03 | 1.13 | 58.4 | 2.03 | 1.13 | 58.5 | 2.03 | 1.14 | 58.7 | 2.03 | 1.14 |
| 15.50 | 57.3 | 2.04 | 1.11 | 57.5 | 2.04 | 1.11 | 57.6 | 2.04 | 1.12 | 57.8 | 2.04 | 1.12 | 58.0 | 2.04 | 1.12 | 58.1 | 2.04 | 1.13 | 58.3 | 2.04 | 1.13 | 58.4 | 2.04 | 1.13 | 58.6 | 2.04 | 1.14 | 58.7 | 2.04 | 1.14 |
| 15.60 | 57.4 | 2.04 | 1.11 | 57.5 | 2.04 | 1.11 | 57.7 | 2.04 | 1.12 | 57.8 | 2.04 | 1.12 | 58.0 | 2.04 | 1.12 | 58.1 | 2.04 | 1.12 | 58.3 | 2.04 | 1.13 | 58.4 | 2.04 | 1.13 | 58.6 | 2.04 | 1.13 | 58.7 | 2.04 | 1.14 |
| 15.70 | 57.4 | 2.04 | 1.11 | 57.5 | 2.04 | 1.11 | 57.7 | 2.04 | 1.11 | 57.8 | 2.04 | 1.12 | 58.0 | 2.04 | 1.12 | 58.1 | 2.04 | 1.12 | 58.3 | 2.04 | 1.13 | 58.4 | 2.04 | 1.13 | 58.6 | 2.04 | 1.13 | 58.7 | 2.04 | 1.13 |
| 15.80 | 57.4 | 2.04 | 1.11 | 57.5 | 2.04 | 1.11 | 57.7 | 2.04 | 1.11 | 57.8 | 2.04 | 1.11 | 58.0 | 2.04 | 1.12 | 58.2 | 2.04 | 1.12 | 58.3 | 2.04 | 1.12 | 58.5 | 2.04 | 1.13 | 58.6 | 2.04 | 1.13 | 58.8 | 2.04 | 1.13 |
| 15.90 | 57.4 | 2.05 | 1.10 | 57.6 | 2.05 | 1.11 | 57.7 | 2.05 | 1.11 | 57.9 | 2.05 | 1.11 | 58.0 | 2.05 | 1.12 | 58.2 | 2.05 | 1.12 | 58.3 | 2.05 | 1.12 | 58.5 | 2.05 | 1.12 | 58.6 | 2.05 | 1.13 | 58.8 | 2.05 | 1.13 |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 2.0; Water (ml) = (% Absorption x 2.0 / 100) + (2.0 - sample weight)

## 2-gram Mixograph: Absorption, Flour and Water Amount Table
## (10.0 - 10.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 10.00 | | | 10.10 | | | 10.20 | | | 10.30 | | | 10.40 | | | 10.50 | | | 10.60 | | | 10.70 | | | 10.80 | | | 10.90 | | | | | | | | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | | | | | | |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | | | | | | |
| 9.00 | 57.8 | 1.89 | 1.27 | 57.9 | 1.89 | 1.27 | 58.1 | 1.89 | 1.27 | 58.2 | 1.89 | 1.27 | 58.3 | 1.89 | 1.28 | 58.5 | 1.89 | 1.28 | 58.6 | 1.89 | 1.28 | 58.8 | 1.89 | 1.29 | 58.9 | 1.89 | 1.29 | 59.1 | 1.89 | 1.29 | | | | | | |
| 9.10 | 57.8 | 1.89 | 1.26 | 57.9 | 1.89 | 1.27 | 58.1 | 1.89 | 1.27 | 58.2 | 1.89 | 1.27 | 58.4 | 1.89 | 1.27 | 58.5 | 1.89 | 1.28 | 58.6 | 1.89 | 1.28 | 58.8 | 1.89 | 1.28 | 58.9 | 1.89 | 1.29 | 59.1 | 1.89 | 1.29 | | | | | | |
| 9.20 | 57.8 | 1.89 | 1.26 | 57.9 | 1.89 | 1.26 | 58.1 | 1.89 | 1.27 | 58.2 | 1.89 | 1.27 | 58.4 | 1.89 | 1.27 | 58.5 | 1.89 | 1.28 | 58.7 | 1.89 | 1.28 | 58.8 | 1.89 | 1.28 | 58.9 | 1.89 | 1.28 | 59.1 | 1.89 | 1.29 | | | | | | |
| 9.30 | 57.8 | 1.90 | 1.26 | 58.0 | 1.90 | 1.26 | 58.1 | 1.90 | 1.27 | 58.2 | 1.90 | 1.27 | 58.4 | 1.90 | 1.27 | 58.5 | 1.90 | 1.27 | 58.7 | 1.90 | 1.28 | 58.8 | 1.90 | 1.28 | 59.0 | 1.90 | 1.28 | 59.1 | 1.90 | 1.29 | | | | | | |
| 9.40 | 57.8 | 1.90 | 1.26 | 58.0 | 1.90 | 1.26 | 58.1 | 1.90 | 1.26 | 58.3 | 1.90 | 1.27 | 58.4 | 1.90 | 1.27 | 58.6 | 1.90 | 1.27 | 58.7 | 1.90 | 1.28 | 58.8 | 1.90 | 1.28 | 59.0 | 1.90 | 1.28 | 59.1 | 1.90 | 1.28 | | | | | | |
| 9.50 | 57.9 | 1.90 | 1.26 | 58.0 | 1.90 | 1.26 | 58.1 | 1.90 | 1.26 | 58.3 | 1.90 | 1.27 | 58.4 | 1.90 | 1.27 | 58.6 | 1.90 | 1.27 | 58.7 | 1.90 | 1.27 | 58.9 | 1.90 | 1.28 | 59.0 | 1.90 | 1.28 | 59.1 | 1.90 | 1.28 | | | | | | |
| 9.60 | 57.9 | 1.90 | 1.25 | 58.0 | 1.90 | 1.26 | 58.2 | 1.90 | 1.26 | 58.3 | 1.90 | 1.26 | 58.4 | 1.90 | 1.27 | 58.6 | 1.90 | 1.27 | 58.7 | 1.90 | 1.27 | 58.9 | 1.90 | 1.27 | 59.0 | 1.90 | 1.28 | 59.2 | 1.90 | 1.28 | | | | | | |
| 9.70 | 57.9 | 1.90 | 1.25 | 58.0 | 1.90 | 1.26 | 58.2 | 1.90 | 1.26 | 58.3 | 1.90 | 1.26 | 58.5 | 1.90 | 1.26 | 58.6 | 1.90 | 1.27 | 58.7 | 1.90 | 1.27 | 58.9 | 1.90 | 1.27 | 59.0 | 1.90 | 1.28 | 59.2 | 1.90 | 1.28 | | | | | | |
| 9.80 | 57.9 | 1.91 | 1.25 | 58.0 | 1.91 | 1.25 | 58.2 | 1.91 | 1.26 | 58.3 | 1.91 | 1.26 | 58.5 | 1.91 | 1.26 | 58.6 | 1.91 | 1.27 | 58.8 | 1.91 | 1.27 | 58.9 | 1.91 | 1.27 | 59.0 | 1.91 | 1.27 | 59.2 | 1.91 | 1.28 | | | | | | |
| 9.90 | 57.9 | 1.91 | 1.25 | 58.1 | 1.91 | 1.25 | 58.2 | 1.91 | 1.26 | 58.3 | 1.91 | 1.26 | 58.5 | 1.91 | 1.26 | 58.6 | 1.91 | 1.26 | 58.8 | 1.91 | 1.27 | 58.9 | 1.91 | 1.27 | 59.1 | 1.91 | 1.27 | 59.2 | 1.91 | 1.28 | | | | | | |
| 10.00 | 57.9 | 1.91 | 1.25 | 58.1 | 1.91 | 1.25 | 58.2 | 1.91 | 1.25 | 58.4 | 1.91 | 1.26 | 58.5 | 1.91 | 1.26 | 58.7 | 1.91 | 1.26 | 58.8 | 1.91 | 1.26 | 58.9 | 1.91 | 1.27 | 59.1 | 1.91 | 1.27 | 59.2 | 1.91 | 1.27 | | | | | | |
| 10.10 | 57.9 | 1.91 | 1.25 | 58.1 | 1.91 | 1.25 | 58.2 | 1.91 | 1.25 | 58.4 | 1.91 | 1.25 | 58.5 | 1.91 | 1.26 | 58.7 | 1.91 | 1.26 | 58.8 | 1.91 | 1.26 | 59.0 | 1.91 | 1.27 | 59.1 | 1.91 | 1.27 | 59.2 | 1.91 | 1.27 | | | | | | |
| 10.20 | 58.0 | 1.92 | 1.24 | 58.1 | 1.92 | 1.25 | 58.3 | 1.92 | 1.25 | 58.4 | 1.92 | 1.25 | 58.5 | 1.92 | 1.26 | 58.7 | 1.92 | 1.26 | 58.8 | 1.92 | 1.26 | 59.0 | 1.92 | 1.26 | 59.1 | 1.92 | 1.27 | 59.3 | 1.92 | 1.27 | | | | | | |
| 10.30 | 58.0 | 1.92 | 1.24 | 58.1 | 1.92 | 1.24 | 58.3 | 1.92 | 1.25 | 58.4 | 1.92 | 1.25 | 58.6 | 1.92 | 1.25 | 58.7 | 1.92 | 1.26 | 58.8 | 1.92 | 1.26 | 59.0 | 1.92 | 1.26 | 59.1 | 1.92 | 1.27 | 59.3 | 1.92 | 1.27 | | | | | | |
| 10.40 | 58.0 | 1.92 | 1.24 | 58.1 | 1.92 | 1.24 | 58.3 | 1.92 | 1.25 | 58.4 | 1.92 | 1.25 | 58.6 | 1.92 | 1.25 | 58.7 | 1.92 | 1.25 | 58.9 | 1.92 | 1.26 | 59.0 | 1.92 | 1.26 | 59.1 | 1.92 | 1.26 | 59.3 | 1.92 | 1.27 | | | | | | |
| 10.50 | 58.0 | 1.92 | 1.24 | 58.2 | 1.92 | 1.24 | 58.3 | 1.92 | 1.24 | 58.4 | 1.92 | 1.25 | 58.6 | 1.92 | 1.25 | 58.7 | 1.92 | 1.25 | 58.9 | 1.92 | 1.26 | 59.0 | 1.92 | 1.26 | 59.2 | 1.92 | 1.26 | 59.3 | 1.92 | 1.26 | | | | | | |
| 10.60 | 58.0 | 1.92 | 1.24 | 58.2 | 1.92 | 1.24 | 58.3 | 1.92 | 1.24 | 58.5 | 1.92 | 1.25 | 58.6 | 1.92 | 1.25 | 58.8 | 1.92 | 1.25 | 58.9 | 1.92 | 1.25 | 59.0 | 1.92 | 1.26 | 59.2 | 1.92 | 1.26 | 59.3 | 1.92 | 1.26 | | | | | | |
| 10.70 | 58.0 | 1.93 | 1.23 | 58.2 | 1.93 | 1.24 | 58.3 | 1.93 | 1.24 | 58.5 | 1.93 | 1.24 | 58.6 | 1.93 | 1.25 | 58.8 | 1.93 | 1.25 | 58.9 | 1.93 | 1.25 | 59.1 | 1.93 | 1.26 | 59.2 | 1.93 | 1.26 | 59.3 | 1.93 | 1.26 | | | | | | |
| 10.80 | 58.1 | 1.93 | 1.23 | 57.6 | 1.93 | 1.22 | 58.4 | 1.93 | 1.24 | 58.5 | 1.93 | 1.24 | 58.6 | 1.93 | 1.24 | 58.8 | 1.93 | 1.25 | 58.3 | 1.93 | 1.24 | 59.1 | 1.93 | 1.25 | 59.2 | 1.93 | 1.26 | 59.4 | 1.93 | 1.26 | | | | | | |
| 10.90 | 58.1 | 1.93 | 1.23 | 58.2 | 1.93 | 1.23 | 58.4 | 1.93 | 1.24 | 58.5 | 1.93 | 1.24 | 58.7 | 1.93 | 1.24 | 58.8 | 1.93 | 1.25 | 58.9 | 1.93 | 1.25 | 59.1 | 1.93 | 1.25 | 59.2 | 1.93 | 1.25 | 59.4 | 1.93 | 1.26 | | | | | | |
| 11.00 | 58.1 | 1.93 | 1.23 | 58.2 | 1.93 | 1.23 | 58.4 | 1.93 | 1.24 | 58.5 | 1.93 | 1.24 | 58.7 | 1.93 | 1.24 | 58.8 | 1.93 | 1.24 | 59.0 | 1.93 | 1.25 | 59.1 | 1.93 | 1.25 | 59.3 | 1.93 | 1.25 | 59.4 | 1.93 | 1.26 | | | | | | |
| 11.10 | 58.1 | 1.93 | 1.23 | 58.3 | 1.93 | 1.23 | 58.4 | 1.93 | 1.23 | 58.5 | 1.93 | 1.24 | 58.7 | 1.93 | 1.24 | 58.8 | 1.93 | 1.24 | 59.0 | 1.93 | 1.24 | 59.1 | 1.93 | 1.25 | 59.3 | 1.93 | 1.25 | 59.4 | 1.93 | 1.25 | | | | | | |
| 11.20 | 58.1 | 1.94 | 1.23 | 58.3 | 1.94 | 1.23 | 58.4 | 1.94 | 1.23 | 58.6 | 1.94 | 1.23 | 58.7 | 1.94 | 1.24 | 58.9 | 1.94 | 1.24 | 59.0 | 1.94 | 1.24 | 59.1 | 1.94 | 1.25 | 59.3 | 1.94 | 1.25 | 59.4 | 1.94 | 1.25 | | | | | | |
| 11.30 | 58.1 | 1.94 | 1.22 | 58.3 | 1.94 | 1.23 | 58.4 | 1.94 | 1.23 | 58.6 | 1.94 | 1.23 | 58.7 | 1.94 | 1.24 | 58.9 | 1.94 | 1.24 | 59.0 | 1.94 | 1.24 | 59.2 | 1.94 | 1.24 | 59.3 | 1.94 | 1.25 | 59.5 | 1.94 | 1.25 | | | | | | |
| 11.40 | 58.2 | 1.94 | 1.22 | 58.3 | 1.94 | 1.22 | 58.5 | 1.94 | 1.23 | 58.6 | 1.94 | 1.23 | 58.7 | 1.94 | 1.23 | 58.9 | 1.94 | 1.24 | 59.0 | 1.94 | 1.24 | 59.2 | 1.94 | 1.24 | 59.3 | 1.94 | 1.25 | 59.5 | 1.94 | 1.25 | | | | | | |
| 11.50 | 58.2 | 1.94 | 1.22 | 58.3 | 1.94 | 1.22 | 58.5 | 1.94 | 1.23 | 58.6 | 1.94 | 1.23 | 58.8 | 1.94 | 1.23 | 58.9 | 1.94 | 1.23 | 59.1 | 1.94 | 1.24 | 59.2 | 1.94 | 1.24 | 59.3 | 1.94 | 1.24 | 59.5 | 1.94 | 1.25 | | | | | | |
| 11.60 | 58.2 | 1.95 | 1.22 | 58.3 | 1.95 | 1.22 | 58.5 | 1.95 | 1.22 | 58.6 | 1.95 | 1.23 | 58.8 | 1.95 | 1.23 | 58.9 | 1.95 | 1.23 | 59.1 | 1.95 | 1.24 | 59.2 | 1.95 | 1.24 | 59.4 | 1.95 | 1.24 | 59.5 | 1.95 | 1.24 | | | | | | |
| 11.70 | 58.2 | 1.95 | 1.22 | 58.4 | 1.95 | 1.22 | 58.5 | 1.95 | 1.22 | 58.6 | 1.95 | 1.23 | 58.8 | 1.95 | 1.23 | 58.9 | 1.95 | 1.23 | 59.1 | 1.95 | 1.23 | 59.2 | 1.95 | 1.24 | 59.4 | 1.95 | 1.24 | 59.5 | 1.95 | 1.24 | | | | | | |
| 11.80 | 58.2 | 1.95 | 1.21 | 58.4 | 1.95 | 1.22 | 58.5 | 1.95 | 1.22 | 58.7 | 1.95 | 1.22 | 58.8 | 1.95 | 1.23 | 59.0 | 1.95 | 1.23 | 59.1 | 1.95 | 1.23 | 59.2 | 1.95 | 1.23 | 59.4 | 1.95 | 1.24 | 59.5 | 1.95 | 1.24 | | | | | | |
| 11.90 | 58.2 | 1.95 | 1.21 | 58.4 | 1.95 | 1.22 | 58.5 | 1.95 | 1.22 | 58.7 | 1.95 | 1.22 | 58.8 | 1.95 | 1.22 | 59.0 | 1.95 | 1.23 | 59.1 | 1.95 | 1.23 | 59.3 | 1.95 | 1.23 | 59.4 | 1.95 | 1.24 | 59.6 | 1.95 | 1.24 | | | | | | |
| 12.00 | 58.3 | 1.95 | 1.21 | 58.4 | 1.95 | 1.21 | 58.6 | 1.95 | 1.22 | 58.7 | 1.95 | 1.22 | 58.8 | 1.95 | 1.22 | 59.0 | 1.95 | 1.23 | 59.1 | 1.95 | 1.23 | 59.3 | 1.95 | 1.23 | 59.4 | 1.95 | 1.23 | 59.6 | 1.95 | 1.24 | | | | | | |
| 12.10 | 58.3 | 1.96 | 1.21 | 58.4 | 1.96 | 1.21 | 58.6 | 1.96 | 1.21 | 58.7 | 1.96 | 1.22 | 58.9 | 1.96 | 1.22 | 59.0 | 1.96 | 1.22 | 59.2 | 1.96 | 1.23 | 59.3 | 1.96 | 1.23 | 59.4 | 1.96 | 1.23 | 59.6 | 1.96 | 1.24 | | | | | | |
| 12.30 | 58.3 | 1.96 | 1.20 | 58.5 | 1.96 | 1.21 | 58.6 | 1.96 | 1.21 | 58.8 | 1.96 | 1.21 | 58.9 | 1.96 | 1.22 | 59.0 | 1.96 | 1.22 | 59.2 | 1.96 | 1.22 | 59.3 | 1.96 | 1.23 | 59.5 | 1.96 | 1.23 | 59.6 | 1.96 | 1.23 | | | | | | |
| 12.30 | 58.3 | 1.96 | 1.20 | 58.5 | 1.96 | 1.21 | 58.6 | 1.96 | 1.21 | 58.8 | 1.96 | 1.21 | 58.9 | 1.96 | 1.22 | 59.0 | 1.96 | 1.22 | 59.2 | 1.96 | 1.22 | 59.3 | 1.96 | 1.23 | 59.5 | 1.96 | 1.23 | 59.6 | 1.96 | 1.23 | | | | | | |
| 12.40 | 58.3 | 1.96 | 1.20 | 58.5 | 1.96 | 1.21 | 58.6 | 1.96 | 1.21 | 58.8 | 1.96 | 1.21 | 58.9 | 1.96 | 1.21 | 59.1 | 1.96 | 1.22 | 59.2 | 1.96 | 1.22 | 59.4 | 1.96 | 1.22 | 59.5 | 1.96 | 1.23 | 59.7 | 1.96 | 1.23 | | | | | | |
| 12.50 | 58.3 | 1.97 | 1.20 | 58.5 | 1.97 | 1.20 | 58.6 | 1.97 | 1.21 | 58.8 | 1.97 | 1.21 | 58.9 | 1.97 | 1.21 | 59.1 | 1.97 | 1.22 | 59.2 | 1.97 | 1.22 | 59.4 | 1.97 | 1.22 | 59.5 | 1.97 | 1.22 | 59.7 | 1.97 | 1.23 | | | | | | |
| 12.60 | 58.4 | 1.97 | 1.20 | 58.5 | 1.97 | 1.20 | 58.7 | 1.97 | 1.21 | 58.8 | 1.97 | 1.21 | 59.0 | 1.97 | 1.21 | 59.1 | 1.97 | 1.21 | 59.2 | 1.97 | 1.22 | 59.4 | 1.97 | 1.22 | 59.5 | 1.97 | 1.22 | 59.7 | 1.97 | 1.23 | | | | | | |
| 12.70 | 58.4 | 1.97 | 1.20 | 58.5 | 1.97 | 1.20 | 58.7 | 1.97 | 1.20 | 58.8 | 1.97 | 1.21 | 59.0 | 1.97 | 1.21 | 59.1 | 1.97 | 1.21 | 59.3 | 1.97 | 1.22 | 59.4 | 1.97 | 1.22 | 59.6 | 1.97 | 1.22 | 59.7 | 1.97 | 1.22 | | | | | | |
| 12.80 | 58.4 | 1.97 | 1.20 | 58.5 | 1.97 | 1.20 | 58.7 | 1.97 | 1.20 | 58.8 | 1.97 | 1.20 | 59.0 | 1.97 | 1.21 | 59.1 | 1.97 | 1.21 | 59.3 | 1.97 | 1.21 | 59.4 | 1.97 | 1.22 | 59.6 | 1.97 | 1.22 | 59.7 | 1.97 | 1.22 | | | | | | |
| 12.90 | 58.4 | 1.97 | 1.19 | 58.6 | 1.97 | 1.20 | 58.7 | 1.97 | 1.20 | 58.9 | 1.97 | 1.20 | 59.0 | 1.97 | 1.21 | 59.2 | 1.97 | 1.21 | 59.3 | 1.97 | 1.21 | 59.4 | 1.97 | 1.21 | 59.6 | 1.97 | 1.22 | 59.7 | 1.97 | 1.22 | | | | | | |
| 13.00 | 58.4 | 1.98 | 1.19 | 58.6 | 1.98 | 1.19 | 58.7 | 1.98 | 1.20 | 58.9 | 1.98 | 1.20 | 59.0 | 1.98 | 1.20 | 59.2 | 1.98 | 1.21 | 59.3 | 1.98 | 1.21 | 59.5 | 1.98 | 1.21 | 59.6 | 1.98 | 1.22 | 59.8 | 1.98 | 1.22 | | | | | | |
| 13.10 | 58.4 | 1.98 | 1.19 | 58.6 | 1.98 | 1.19 | 58.7 | 1.98 | 1.20 | 58.9 | 1.98 | 1.20 | 59.0 | 1.98 | 1.20 | 59.2 | 1.98 | 1.20 | 59.3 | 1.98 | 1.21 | 59.5 | 1.98 | 1.21 | 59.6 | 1.98 | 1.21 | 59.8 | 1.98 | 1.22 | | | | | | |
| 13.20 | 58.5 | 1.98 | 1.19 | 58.6 | 1.98 | 1.19 | 58.8 | 1.98 | 1.19 | 58.9 | 1.98 | 1.20 | 59.1 | 1.98 | 1.20 | 59.2 | 1.98 | 1.20 | 59.4 | 1.98 | 1.21 | 59.5 | 1.98 | 1.21 | 59.7 | 1.98 | 1.21 | 59.8 | 1.98 | 1.21 | | | | | | |
| 13.30 | 58.5 | 1.98 | 1.19 | 58.6 | 1.98 | 1.19 | 58.8 | 1.98 | 1.19 | 58.9 | 1.98 | 1.19 | 59.1 | 1.98 | 1.20 | 59.2 | 1.98 | 1.20 | 59.4 | 1.98 | 1.20 | 59.5 | 1.98 | 1.21 | 59.7 | 1.98 | 1.21 | 59.8 | 1.98 | 1.21 | | | | | | |
| 13.40 | 58.5 | 1.99 | 1.18 | 58.6 | 1.99 | 1.19 | 58.8 | 1.99 | 1.19 | 58.9 | 1.99 | 1.19 | 59.1 | 1.99 | 1.20 | 59.2 | 1.99 | 1.20 | 59.4 | 1.99 | 1.20 | 59.5 | 1.99 | 1.20 | 59.7 | 1.99 | 1.21 | 59.8 | 1.99 | 1.21 | | | | | | |
| 13.50 | 58.5 | 1.99 | 1.18 | 58.7 | 1.99 | 1.18 | 58.8 | 1.99 | 1.19 | 59.0 | 1.99 | 1.19 | 59.1 | 1.99 | 1.19 | 59.3 | 1.99 | 1.20 | 59.4 | 1.99 | 1.20 | 59.6 | 1.99 | 1.20 | 59.7 | 1.99 | 1.21 | 59.9 | 1.99 | 1.21 | | | | | | |
| 13.60 | 58.5 | 1.99 | 1.18 | 58.7 | 1.99 | 1.18 | 58.8 | 1.99 | 1.19 | 59.0 | 1.99 | 1.19 | 59.1 | 1.99 | 1.19 | 59.3 | 1.99 | 1.19 | 59.4 | 1.99 | 1.20 | 59.6 | 1.99 | 1.20 | 59.7 | 1.99 | 1.20 | 59.9 | 1.99 | 1.21 | | | | | | |
| 13.70 | 58.5 | 1.99 | 1.18 | 58.7 | 1.99 | 1.18 | 58.8 | 1.99 | 1.18 | 59.0 | 1.99 | 1.19 | 59.1 | 1.99 | 1.19 | 59.3 | 1.99 | 1.19 | 59.4 | 1.99 | 1.20 | 59.6 | 1.99 | 1.20 | 59.7 | 1.99 | 1.20 | 59.9 | 1.99 | 1.20 | | | | | | |
| 13.80 | 58.6 | 2.00 | 1.18 | 58.7 | 2.00 | 1.18 | 58.9 | 2.00 | 1.18 | 59.0 | 2.00 | 1.18 | 59.2 | 2.00 | 1.19 | 59.3 | 2.00 | 1.19 | 59.5 | 2.00 | 1.19 | 59.6 | 2.00 | 1.20 | 59.8 | 2.00 | 1.20 | 59.9 | 2.00 | 1.20 | | | | | | |
| 13.90 | 58.6 | 2.00 | 1.17 | 58.7 | 2.00 | 1.18 | 58.9 | 2.00 | 1.18 | 59.0 | 2.00 | 1.18 | 59.2 | 2.00 | 1.19 | 59.3 | 2.00 | 1.19 | 59.5 | 2.00 | 1.19 | 59.6 | 2.00 | 1.19 | 59.8 | 2.00 | 1.20 | 59.9 | 2.00 | 1.20 | | | | | | |
| 14.00 | 58.6 | 2.00 | 1.17 | 58.8 | 2.00 | 1.18 | 58.9 | 2.00 | 1.18 | 59.1 | 2.00 | 1.18 | 59.2 | 2.00 | 1.18 | 59.4 | 2.00 | 1.19 | 59.5 | 2.00 | 1.19 | 59.7 | 2.00 | 1.19 | 59.8 | 2.00 | 1.20 | 60.0 | 2.00 | 1.20 | | | | | | |
| 14.10 | 58.6 | 2.00 | 1.17 | 58.8 | 2.00 | 1.17 | 58.9 | 2.00 | 1.18 | 59.1 | 2.00 | 1.18 | 59.2 | 2.00 | 1.18 | 59.4 | 2.00 | 1.19 | 59.5 | 2.00 | 1.19 | 59.7 | 2.00 | 1.19 | 59.8 | 2.00 | 1.19 | 60.0 | 2.00 | 1.20 | | | | | | |
| 14.20 | 58.6 | 2.00 | 1.17 | 58.8 | 2.00 | 1.17 | 58.9 | 2.00 | 1.17 | 59.1 | 2.00 | 1.18 | 59.2 | 2.00 | 1.18 | 59.4 | 2.00 | 1.18 | 59.5 | 2.00 | 1.19 | 59.7 | 2.00 | 1.19 | 59.8 | 2.00 | 1.19 | 60.0 | 2.00 | 1.20 | | | | | | |
| 14.30 | 58.7 | 2.01 | 1.17 | 58.8 | 2.01 | 1.17 | 59.0 | 2.01 | 1.17 | 59.1 | 2.01 | 1.18 | 59.3 | 2.01 | 1.18 | 59.4 | 2.01 | 1.18 | 59.6 | 2.01 | 1.18 | 59.7 | 2.01 | 1.19 | 59.9 | 2.01 | 1.19 | 60.0 | 2.01 | 1.19 | | | | | | |
| 14.40 | 58.7 | 2.01 | 1.16 | 58.8 | 2.01 | 1.17 | 59.0 | 2.01 | 1.17 | 59.1 | 2.01 | 1.17 | 59.3 | 2.01 | 1.18 | 59.4 | 2.01 | 1.18 | 59.6 | 2.01 | 1.18 | 59.7 | 2.01 | 1.19 | 59.9 | 2.01 | 1.19 | 60.0 | 2.01 | 1.19 | | | | | | |
| 14.50 | 58.7 | 2.01 | 1.16 | 58.8 | 2.01 | 1.17 | 59.0 | 2.01 | 1.17 | 59.1 | 2.01 | 1.17 | 59.3 | 2.01 | 1.17 | 59.4 | 2.01 | 1.18 | 59.6 | 2.01 | 1.18 | 59.7 | 2.01 | 1.18 | 59.9 | 2.01 | 1.19 | 60.0 | 2.01 | 1.19 | | | | | | |
| 14.60 | 58.7 | 2.01 | 1.16 | 58.9 | 2.01 | 1.16 | 59.0 | 2.01 | 1.17 | 59.2 | 2.01 | 1.17 | 59.3 | 2.01 | 1.17 | 59.5 | 2.01 | 1.18 | 59.6 | 2.01 | 1.18 | 59.8 | 2.01 | 1.18 | 59.9 | 2.01 | 1.18 | 60.1 | 2.01 | 1.19 | | | | | | |
| 14.70 | 58.7 | 2.02 | 1.16 | 58.9 | 2.02 | 1.16 | 59.0 | 2.02 | 1.16 | 59.2 | 2.02 | 1.17 | 59.3 | 2.02 | 1.17 | 59.5 | 2.02 | 1.17 | 59.6 | 2.02 | 1.18 | 59.8 | 2.02 | 1.18 | 59.9 | 2.02 | 1.18 | 60.1 | 2.02 | 1.19 | | | | | | |
| 14.80 | 58.7 | 2.02 | 1.16 | 58.9 | 2.02 | 1.16 | 59.0 | 2.02 | 1.16 | 59.2 | 2.02 | 1.17 | 59.3 | 2.02 | 1.17 | 59.5 | 2.02 | 1.17 | 59.6 | 2.02 | 1.17 | 59.8 | 2.02 | 1.18 | 60.0 | 2.02 | 1.18 | 60.1 | 2.02 | 1.18 | | | | | | |
| 14.90 | 58.8 | 2.02 | 1.15 | 58.9 | 2.02 | 1.16 | 59.1 | 2.02 | 1.16 | 59.2 | 2.02 | 1.16 | 59.4 | 2.02 | 1.17 | 59.5 | 2.02 | 1.17 | 59.7 | 2.02 | 1.17 | 59.8 | 2.02 | 1.18 | 60.0 | 2.02 | 1.18 | 60.1 | 2.02 | 1.18 | | | | | | |
| 15.00 | 58.8 | 2.02 | 1.15 | 58.9 | 2.02 | 1.16 | 59.1 | 2.02 | 1.16 | 59.2 | 2.02 | 1.16 | 59.4 | 2.02 | 1.16 | 59.5 | 2.02 | 1.17 | 59.7 | 2.02 | 1.17 | 59.8 | 2.02 | 1.17 | 60.0 | 2.02 | 1.18 | 60.1 | 2.02 | 1.18 | | | | | | |
| 15.10 | 58.8 | 2.03 | 1.15 | 58.9 | 2.03 | 1.15 | 59.1 | 2.03 | 1.16 | 59.3 | 2.03 | 1.16 | 59.4 | 2.03 | 1.16 | 59.6 | 2.03 | 1.17 | 59.7 | 2.03 | 1.17 | 59.9 | 2.03 | 1.17 | 60.0 | 2.03 | 1.17 | 60.2 | 2.03 | 1.18 | | | | | | |
| 15.20 | 58.8 | 2.03 | 1.15 | 59.0 | 2.03 | 1.15 | 59.1 | 2.03 | 1.15 | 59.3 | 2.03 | 1.16 | 59.4 | 2.03 | 1.16 | 59.6 | 2.03 | 1.16 | 59.7 | 2.03 | 1.17 | 59.9 | 2.03 | 1.17 | 60.0 | 2.03 | 1.17 | 60.2 | 2.03 | 1.18 | | | | | | |
| 15.30 | 58.8 | 2.03 | 1.15 | 59.0 | 2.03 | 1.15 | 59.1 | 2.03 | 1.15 | 59.3 | 2.03 | 1.16 | 59.4 | 2.03 | 1.16 | 59.6 | 2.03 | 1.16 | 59.7 | 2.03 | 1.16 | 59.9 | 2.03 | 1.17 | 60.0 | 2.03 | 1.17 | 60.2 | 2.03 | 1.17 | | | | | | |
| 15.40 | 58.8 | 2.03 | 1.14 | 59.0 | 2.03 | 1.15 | 59.2 | 2.03 | 1.15 | 59.3 | 2.03 | 1.15 | 59.5 | 2.03 | 1.16 | 59.6 | 2.03 | 1.16 | 59.8 | 2.03 | 1.16 | 59.9 | 2.03 | 1.17 | 60.1 | 2.03 | 1.17 | 60.2 | 2.03 | 1.17 | | | | | | |
| 15.50 | 58.9 | 2.04 | 1.14 | 59.0 | 2.04 | 1.14 | 59.2 | 2.04 | 1.15 | 59.3 | 2.04 | 1.15 | 59.5 | 2.04 | 1.15 | 59.6 | 2.04 | 1.16 | 59.8 | 2.04 | 1.16 | 59.9 | 2.04 | 1.16 | 60.1 | 2.04 | 1.17 | 60.2 | 2.04 | 1.17 | | | | | | |
| 15.60 | 58.9 | 2.04 | 1.14 | 59.0 | 2.04 | 1.14 | 59.2 | 2.04 | 1.15 | 59.3 | 2.04 | 1.15 | 59.5 | 2.04 | 1.15 | 59.6 | 2.04 | 1.16 | 59.8 | 2.04 | 1.16 | 60.0 | 2.04 | 1.16 | 60.1 | 2.04 | 1.16 | 60.3 | 2.04 | 1.17 | | | | | | |
| 15.70 | 58.9 | 2.04 | 1.14 | 59.1 | 2.04 | 1.14 | 59.2 | 2.04 | 1.14 | 59.4 | 2.04 | 1.15 | 59.5 | 2.04 | 1.15 | 59.7 | 2.04 | 1.15 | 59.8 | 2.04 | 1.16 | 60.0 | 2.04 | 1.16 | 60.1 | 2.04 | 1.16 | 60.3 | 2.04 | 1.17 | | | | | | |
| 15.80 | 58.9 | 2.04 | 1.14 | 59.1 | 2.04 | 1.14 | 59.2 | 2.04 | 1.14 | 59.4 | 2.04 | 1.14 | 59.5 | 2.04 | 1.15 | 59.7 | 2.04 | 1.15 | 59.8 | 2.04 | 1.15 | 60.0 | 2.04 | 1.16 | 60.1 | 2.04 | 1.16 | 60.3 | 2.04 | 1.16 | | | | | | |
| 15.90 | 58.9 | 2.05 | 1.13 | 59.1 | 2.05 | 1.14 | 59.2 | 2.05 | 1.14 | 59.4 | 2.05 | 1.14 | 59.6 | 2.05 | 1.15 | 59.7 | 2.05 | 1.15 | 59.9 | 2.05 | 1.15 | 60.0 | 2.05 | 1.16 | 60.2 | 2.05 | 1.16 | 60.3 | 2.05 | 1.16 | | | | | | |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 2.0; Water (ml) = (% Absorption x 2.0 / 100) + (2.0 - sample weight)

## 2-gram Mixograph: Absorption, Flour and Water Amount Table
## (11.0 - 11.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 11.00 | | | 11.10 | | | 11.20 | | | 11.30 | | | 11.40 | | | 11.50 | | | 11.60 | | | 11.70 | | | 11.80 | | | 11.90 | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml |
| 9.00 | 59.2 | 1.89 | 1.29 | 59.3 | 1.89 | 1.30 | 59.5 | 1.89 | 1.30 | 59.6 | 1.89 | 1.30 | 59.8 | 1.89 | 1.31 | 59.9 | 1.89 | 1.31 | 60.0 | 1.89 | 1.31 | 60.2 | 1.89 | 1.31 | 60.3 | 1.89 | 1.32 | 60.5 | 1.89 | 1.32 |
| 9.10 | 59.2 | 1.89 | 1.29 | 59.4 | 1.89 | 1.29 | 59.5 | 1.89 | 1.30 | 59.6 | 1.89 | 1.30 | 59.8 | 1.89 | 1.30 | 59.9 | 1.89 | 1.31 | 60.1 | 1.89 | 1.31 | 60.2 | 1.89 | 1.31 | 60.3 | 1.89 | 1.31 | 60.5 | 1.89 | 1.32 |
| 9.20 | 59.2 | 1.89 | 1.29 | 59.4 | 1.89 | 1.29 | 59.5 | 1.89 | 1.30 | 59.7 | 1.89 | 1.30 | 59.8 | 1.89 | 1.30 | 59.9 | 1.89 | 1.30 | 60.1 | 1.89 | 1.31 | 60.2 | 1.89 | 1.31 | 60.4 | 1.89 | 1.31 | 60.5 | 1.89 | 1.32 |
| 9.30 | 59.2 | 1.90 | 1.29 | 59.4 | 1.90 | 1.29 | 59.5 | 1.90 | 1.29 | 59.7 | 1.90 | 1.30 | 59.8 | 1.90 | 1.30 | 60.0 | 1.90 | 1.30 | 60.1 | 1.90 | 1.31 | 60.2 | 1.90 | 1.31 | 60.4 | 1.90 | 1.31 | 60.5 | 1.90 | 1.31 |
| 9.40 | 59.3 | 1.90 | 1.29 | 59.4 | 1.90 | 1.29 | 59.5 | 1.90 | 1.29 | 59.7 | 1.90 | 1.30 | 59.8 | 1.90 | 1.30 | 60.0 | 1.90 | 1.30 | 60.1 | 1.90 | 1.30 | 60.3 | 1.90 | 1.31 | 60.4 | 1.90 | 1.31 | 60.5 | 1.90 | 1.31 |
| 9.50 | 59.3 | 1.90 | 1.29 | 59.4 | 1.90 | 1.29 | 59.6 | 1.90 | 1.29 | 59.7 | 1.90 | 1.29 | 59.8 | 1.90 | 1.30 | 60.0 | 1.90 | 1.30 | 60.1 | 1.90 | 1.30 | 60.3 | 1.90 | 1.30 | 60.4 | 1.90 | 1.31 | 60.6 | 1.90 | 1.31 |
| 9.60 | 59.3 | 1.90 | 1.28 | 59.4 | 1.90 | 1.29 | 59.6 | 1.90 | 1.29 | 59.7 | 1.90 | 1.29 | 59.9 | 1.90 | 1.29 | 60.0 | 1.90 | 1.30 | 60.2 | 1.90 | 1.30 | 60.3 | 1.90 | 1.30 | 60.4 | 1.90 | 1.31 | 60.6 | 1.90 | 1.31 |
| 9.70 | 59.3 | 1.90 | 1.28 | 59.5 | 1.90 | 1.28 | 59.6 | 1.90 | 1.29 | 59.7 | 1.90 | 1.29 | 59.9 | 1.90 | 1.29 | 60.0 | 1.90 | 1.30 | 60.2 | 1.90 | 1.30 | 60.3 | 1.90 | 1.30 | 60.5 | 1.90 | 1.30 | 60.6 | 1.90 | 1.31 |
| 9.80 | 59.3 | 1.91 | 1.28 | 59.5 | 1.91 | 1.28 | 59.6 | 1.91 | 1.29 | 59.8 | 1.91 | 1.29 | 59.9 | 1.91 | 1.29 | 60.0 | 1.91 | 1.29 | 60.2 | 1.91 | 1.30 | 60.3 | 1.91 | 1.30 | 60.5 | 1.91 | 1.30 | 60.6 | 1.91 | 1.31 |
| 9.90 | 59.3 | 1.91 | 1.28 | 59.5 | 1.91 | 1.28 | 59.6 | 1.91 | 1.28 | 59.8 | 1.91 | 1.29 | 59.9 | 1.91 | 1.29 | 60.1 | 1.91 | 1.29 | 60.2 | 1.91 | 1.30 | 60.4 | 1.91 | 1.30 | 60.5 | 1.91 | 1.30 | 60.6 | 1.91 | 1.30 |
| 10.00 | 59.4 | 1.91 | 1.28 | 59.5 | 1.91 | 1.28 | 59.7 | 1.91 | 1.28 | 59.8 | 1.91 | 1.28 | 59.9 | 1.91 | 1.29 | 60.1 | 1.91 | 1.29 | 60.2 | 1.91 | 1.29 | 60.4 | 1.91 | 1.30 | 60.5 | 1.91 | 1.30 | 60.7 | 1.91 | 1.30 |
| 10.10 | 59.4 | 1.91 | 1.27 | 59.5 | 1.91 | 1.28 | 59.7 | 1.91 | 1.28 | 59.8 | 1.91 | 1.28 | 60.0 | 1.91 | 1.29 | 60.1 | 1.91 | 1.29 | 60.2 | 1.91 | 1.29 | 60.4 | 1.91 | 1.29 | 60.5 | 1.91 | 1.30 | 60.7 | 1.91 | 1.30 |
| 10.20 | 59.4 | 1.92 | 1.27 | 59.5 | 1.92 | 1.28 | 59.7 | 1.92 | 1.28 | 59.8 | 1.92 | 1.28 | 60.0 | 1.92 | 1.28 | 60.1 | 1.92 | 1.29 | 60.3 | 1.92 | 1.29 | 60.4 | 1.92 | 1.29 | 60.6 | 1.92 | 1.30 | 60.7 | 1.92 | 1.30 |
| 10.30 | 59.4 | 1.92 | 1.27 | 59.6 | 1.92 | 1.27 | 59.7 | 1.92 | 1.28 | 59.9 | 1.92 | 1.28 | 60.0 | 1.92 | 1.28 | 60.1 | 1.92 | 1.29 | 60.3 | 1.92 | 1.29 | 60.4 | 1.92 | 1.29 | 60.6 | 1.92 | 1.29 | 60.7 | 1.92 | 1.30 |
| 10.40 | 59.4 | 1.92 | 1.27 | 59.6 | 1.92 | 1.27 | 59.7 | 1.92 | 1.27 | 59.9 | 1.92 | 1.28 | 60.0 | 1.92 | 1.28 | 60.2 | 1.92 | 1.28 | 60.3 | 1.92 | 1.29 | 60.4 | 1.92 | 1.29 | 60.6 | 1.92 | 1.29 | 60.7 | 1.92 | 1.30 |
| 10.50 | 59.5 | 1.92 | 1.27 | 59.6 | 1.92 | 1.27 | 59.7 | 1.92 | 1.27 | 59.9 | 1.92 | 1.28 | 60.0 | 1.92 | 1.28 | 60.2 | 1.92 | 1.28 | 60.3 | 1.92 | 1.28 | 60.5 | 1.92 | 1.29 | 60.6 | 1.92 | 1.29 | 60.8 | 1.92 | 1.29 |
| 10.60 | 59.5 | 1.92 | 1.27 | 59.6 | 1.92 | 1.27 | 59.8 | 1.92 | 1.27 | 59.9 | 1.92 | 1.27 | 60.0 | 1.92 | 1.28 | 60.2 | 1.92 | 1.28 | 60.3 | 1.92 | 1.28 | 60.5 | 1.92 | 1.29 | 60.6 | 1.92 | 1.29 | 60.8 | 1.92 | 1.29 |
| 10.70 | 59.5 | 1.93 | 1.26 | 59.6 | 1.93 | 1.27 | 59.8 | 1.93 | 1.27 | 59.9 | 1.93 | 1.27 | 60.1 | 1.93 | 1.28 | 60.2 | 1.93 | 1.28 | 60.4 | 1.93 | 1.28 | 60.5 | 1.93 | 1.28 | 60.6 | 1.93 | 1.29 | 60.8 | 1.93 | 1.29 |
| 10.80 | 59.5 | 1.93 | 1.26 | 59.1 | 1.93 | 1.25 | 59.8 | 1.93 | 1.27 | 59.9 | 1.93 | 1.27 | 60.1 | 1.93 | 1.27 | 60.2 | 1.93 | 1.28 | 59.8 | 1.93 | 1.27 | 60.5 | 1.93 | 1.28 | 60.7 | 1.93 | 1.29 | 60.8 | 1.93 | 1.29 |
| 10.90 | 59.5 | 1.93 | 1.26 | 59.7 | 1.93 | 1.26 | 59.8 | 1.93 | 1.27 | 60.0 | 1.93 | 1.27 | 60.1 | 1.93 | 1.27 | 60.2 | 1.93 | 1.27 | 60.4 | 1.93 | 1.28 | 60.5 | 1.93 | 1.28 | 60.7 | 1.93 | 1.28 | 60.8 | 1.93 | 1.29 |
| 11.00 | 59.5 | 1.93 | 1.26 | 59.7 | 1.93 | 1.26 | 59.8 | 1.93 | 1.26 | 60.0 | 1.93 | 1.27 | 60.1 | 1.93 | 1.27 | 60.3 | 1.93 | 1.27 | 60.4 | 1.93 | 1.28 | 60.6 | 1.93 | 1.28 | 60.7 | 1.93 | 1.28 | 60.8 | 1.93 | 1.28 |
| 11.10 | 59.6 | 1.93 | 1.26 | 59.7 | 1.93 | 1.26 | 59.9 | 1.93 | 1.26 | 60.0 | 1.93 | 1.27 | 60.1 | 1.93 | 1.27 | 60.3 | 1.93 | 1.27 | 60.4 | 1.93 | 1.27 | 60.6 | 1.93 | 1.28 | 60.7 | 1.93 | 1.28 | 60.9 | 1.93 | 1.28 |
| 11.20 | 59.6 | 1.94 | 1.25 | 59.7 | 1.94 | 1.26 | 59.9 | 1.94 | 1.26 | 60.0 | 1.94 | 1.26 | 60.2 | 1.94 | 1.27 | 60.3 | 1.94 | 1.27 | 60.5 | 1.94 | 1.27 | 60.6 | 1.94 | 1.27 | 60.7 | 1.94 | 1.28 | 60.9 | 1.94 | 1.28 |
| 11.30 | 59.6 | 1.94 | 1.25 | 59.7 | 1.94 | 1.26 | 59.9 | 1.94 | 1.26 | 60.0 | 1.94 | 1.26 | 60.2 | 1.94 | 1.26 | 60.3 | 1.94 | 1.27 | 60.5 | 1.94 | 1.27 | 60.6 | 1.94 | 1.27 | 60.8 | 1.94 | 1.28 | 60.9 | 1.94 | 1.28 |
| 11.40 | 59.6 | 1.94 | 1.25 | 59.8 | 1.94 | 1.25 | 59.9 | 1.94 | 1.26 | 60.1 | 1.94 | 1.26 | 60.2 | 1.94 | 1.26 | 60.3 | 1.94 | 1.27 | 60.5 | 1.94 | 1.27 | 60.6 | 1.94 | 1.27 | 60.8 | 1.94 | 1.27 | 60.9 | 1.94 | 1.28 |
| 11.50 | 59.6 | 1.94 | 1.25 | 59.8 | 1.94 | 1.25 | 59.9 | 1.94 | 1.26 | 60.1 | 1.94 | 1.26 | 60.2 | 1.94 | 1.26 | 60.4 | 1.94 | 1.26 | 60.5 | 1.94 | 1.27 | 60.7 | 1.94 | 1.27 | 60.8 | 1.94 | 1.27 | 60.9 | 1.94 | 1.28 |
| 11.60 | 59.7 | 1.95 | 1.25 | 59.8 | 1.95 | 1.25 | 59.9 | 1.95 | 1.25 | 60.1 | 1.95 | 1.26 | 60.2 | 1.95 | 1.26 | 60.4 | 1.95 | 1.26 | 60.5 | 1.95 | 1.26 | 60.7 | 1.95 | 1.27 | 60.8 | 1.95 | 1.27 | 61.0 | 1.95 | 1.27 |
| 11.70 | 59.7 | 1.95 | 1.25 | 59.8 | 1.95 | 1.25 | 60.0 | 1.95 | 1.25 | 60.1 | 1.95 | 1.25 | 60.3 | 1.95 | 1.26 | 60.4 | 1.95 | 1.26 | 60.5 | 1.95 | 1.26 | 60.7 | 1.95 | 1.27 | 60.8 | 1.95 | 1.27 | 61.0 | 1.95 | 1.27 |
| 11.80 | 59.7 | 1.95 | 1.24 | 59.8 | 1.95 | 1.25 | 60.0 | 1.95 | 1.25 | 60.1 | 1.95 | 1.25 | 60.3 | 1.95 | 1.26 | 60.4 | 1.95 | 1.26 | 60.6 | 1.95 | 1.26 | 60.7 | 1.95 | 1.26 | 60.9 | 1.95 | 1.27 | 61.0 | 1.95 | 1.27 |
| 11.90 | 59.7 | 1.95 | 1.24 | 59.9 | 1.95 | 1.24 | 60.0 | 1.95 | 1.25 | 60.1 | 1.95 | 1.25 | 60.3 | 1.95 | 1.25 | 60.4 | 1.95 | 1.26 | 60.6 | 1.95 | 1.26 | 60.7 | 1.95 | 1.26 | 60.9 | 1.95 | 1.27 | 61.0 | 1.95 | 1.27 |
| 12.00 | 59.7 | 1.95 | 1.24 | 59.9 | 1.95 | 1.24 | 60.0 | 1.95 | 1.25 | 60.2 | 1.95 | 1.25 | 60.3 | 1.95 | 1.25 | 60.5 | 1.95 | 1.25 | 60.6 | 1.95 | 1.26 | 60.8 | 1.95 | 1.26 | 60.9 | 1.95 | 1.26 | 61.0 | 1.95 | 1.27 |
| 12.10 | 59.7 | 1.96 | 1.24 | 59.9 | 1.96 | 1.24 | 60.0 | 1.96 | 1.24 | 60.2 | 1.96 | 1.25 | 60.3 | 1.96 | 1.25 | 60.5 | 1.96 | 1.25 | 60.6 | 1.96 | 1.26 | 60.8 | 1.96 | 1.26 | 60.9 | 1.96 | 1.26 | 61.1 | 1.96 | 1.26 |
| 12.30 | 59.8 | 1.96 | 1.23 | 59.9 | 1.96 | 1.24 | 60.1 | 1.96 | 1.24 | 60.2 | 1.96 | 1.24 | 60.4 | 1.96 | 1.25 | 60.5 | 1.96 | 1.25 | 60.7 | 1.96 | 1.25 | 60.8 | 1.96 | 1.25 | 61.0 | 1.96 | 1.26 | 61.1 | 1.96 | 1.26 |
| 12.30 | 59.8 | 1.96 | 1.23 | 59.9 | 1.96 | 1.24 | 60.1 | 1.96 | 1.24 | 60.2 | 1.96 | 1.24 | 60.4 | 1.96 | 1.25 | 60.5 | 1.96 | 1.25 | 60.7 | 1.96 | 1.25 | 60.8 | 1.96 | 1.25 | 61.0 | 1.96 | 1.26 | 61.1 | 1.96 | 1.26 |
| 12.40 | 59.8 | 1.96 | 1.23 | 59.9 | 1.96 | 1.24 | 60.1 | 1.96 | 1.24 | 60.2 | 1.96 | 1.24 | 60.4 | 1.96 | 1.24 | 60.5 | 1.96 | 1.25 | 60.7 | 1.96 | 1.25 | 60.8 | 1.96 | 1.25 | 61.0 | 1.96 | 1.26 | 61.1 | 1.96 | 1.26 |
| 12.50 | 59.8 | 1.97 | 1.23 | 60.0 | 1.97 | 1.23 | 60.1 | 1.97 | 1.24 | 60.3 | 1.97 | 1.24 | 60.4 | 1.97 | 1.24 | 60.6 | 1.97 | 1.25 | 60.7 | 1.97 | 1.25 | 60.8 | 1.97 | 1.25 | 61.0 | 1.97 | 1.25 | 61.1 | 1.97 | 1.26 |
| 12.60 | 59.8 | 1.97 | 1.23 | 60.0 | 1.97 | 1.23 | 60.1 | 1.97 | 1.23 | 60.3 | 1.97 | 1.24 | 60.4 | 1.97 | 1.24 | 60.6 | 1.97 | 1.24 | 60.7 | 1.97 | 1.25 | 60.9 | 1.97 | 1.25 | 61.0 | 1.97 | 1.25 | 61.2 | 1.97 | 1.26 |
| 12.70 | 59.9 | 1.97 | 1.23 | 60.0 | 1.97 | 1.23 | 60.1 | 1.97 | 1.23 | 60.3 | 1.97 | 1.24 | 60.4 | 1.97 | 1.24 | 60.6 | 1.97 | 1.24 | 60.7 | 1.97 | 1.24 | 60.9 | 1.97 | 1.25 | 61.0 | 1.97 | 1.25 | 61.2 | 1.97 | 1.25 |
| 12.80 | 59.9 | 1.97 | 1.22 | 60.0 | 1.97 | 1.23 | 60.2 | 1.97 | 1.23 | 60.3 | 1.97 | 1.23 | 60.5 | 1.97 | 1.24 | 60.6 | 1.97 | 1.24 | 60.8 | 1.97 | 1.24 | 60.9 | 1.97 | 1.25 | 61.1 | 1.97 | 1.25 | 61.2 | 1.97 | 1.25 |
| 12.90 | 59.9 | 1.97 | 1.22 | 60.0 | 1.97 | 1.23 | 60.2 | 1.97 | 1.23 | 60.3 | 1.97 | 1.23 | 60.5 | 1.97 | 1.23 | 60.6 | 1.97 | 1.24 | 60.8 | 1.97 | 1.24 | 60.9 | 1.97 | 1.24 | 61.1 | 1.97 | 1.25 | 61.2 | 1.97 | 1.25 |
| 13.00 | 59.9 | 1.98 | 1.22 | 60.1 | 1.98 | 1.22 | 60.2 | 1.98 | 1.23 | 60.4 | 1.98 | 1.23 | 60.5 | 1.98 | 1.23 | 60.7 | 1.98 | 1.24 | 60.8 | 1.98 | 1.24 | 60.9 | 1.98 | 1.24 | 61.1 | 1.98 | 1.24 | 61.2 | 1.98 | 1.25 |
| 13.10 | 59.9 | 1.98 | 1.22 | 60.1 | 1.98 | 1.22 | 60.2 | 1.98 | 1.23 | 60.4 | 1.98 | 1.23 | 60.5 | 1.98 | 1.23 | 60.7 | 1.98 | 1.23 | 60.8 | 1.98 | 1.24 | 61.0 | 1.98 | 1.24 | 61.1 | 1.98 | 1.24 | 61.3 | 1.98 | 1.25 |
| 13.20 | 59.9 | 1.98 | 1.22 | 60.1 | 1.98 | 1.22 | 60.2 | 1.98 | 1.22 | 60.4 | 1.98 | 1.23 | 60.5 | 1.98 | 1.23 | 60.7 | 1.98 | 1.23 | 60.8 | 1.98 | 1.24 | 61.0 | 1.98 | 1.24 | 61.1 | 1.98 | 1.24 | 61.3 | 1.98 | 1.24 |
| 13.30 | 60.0 | 1.98 | 1.22 | 60.1 | 1.98 | 1.22 | 60.3 | 1.98 | 1.22 | 60.4 | 1.98 | 1.22 | 60.6 | 1.98 | 1.23 | 60.7 | 1.98 | 1.23 | 60.9 | 1.98 | 1.23 | 61.0 | 1.98 | 1.24 | 61.2 | 1.98 | 1.24 | 61.3 | 1.98 | 1.24 |
| 13.40 | 60.0 | 1.99 | 1.21 | 60.1 | 1.99 | 1.22 | 60.3 | 1.99 | 1.22 | 60.4 | 1.99 | 1.22 | 60.6 | 1.99 | 1.23 | 60.7 | 1.99 | 1.23 | 60.9 | 1.99 | 1.23 | 61.0 | 1.99 | 1.23 | 61.2 | 1.99 | 1.24 | 61.3 | 1.99 | 1.24 |
| 13.50 | 60.0 | 1.99 | 1.21 | 60.2 | 1.99 | 1.21 | 60.3 | 1.99 | 1.22 | 60.5 | 1.99 | 1.22 | 60.6 | 1.99 | 1.22 | 60.8 | 1.99 | 1.23 | 60.9 | 1.99 | 1.23 | 61.0 | 1.99 | 1.23 | 61.2 | 1.99 | 1.24 | 61.3 | 1.99 | 1.24 |
| 13.60 | 60.0 | 1.99 | 1.21 | 60.2 | 1.99 | 1.21 | 60.3 | 1.99 | 1.22 | 60.5 | 1.99 | 1.22 | 60.6 | 1.99 | 1.22 | 60.8 | 1.99 | 1.22 | 60.9 | 1.99 | 1.23 | 61.1 | 1.99 | 1.23 | 61.2 | 1.99 | 1.23 | 61.4 | 1.99 | 1.24 |
| 13.70 | 60.0 | 1.99 | 1.21 | 60.2 | 1.99 | 1.21 | 60.3 | 1.99 | 1.21 | 60.5 | 1.99 | 1.22 | 60.6 | 1.99 | 1.22 | 60.8 | 1.99 | 1.22 | 60.9 | 1.99 | 1.23 | 61.1 | 1.99 | 1.23 | 61.2 | 1.99 | 1.23 | 61.4 | 1.99 | 1.23 |
| 13.80 | 60.1 | 2.00 | 1.21 | 60.2 | 2.00 | 1.21 | 60.4 | 2.00 | 1.21 | 60.5 | 2.00 | 1.21 | 60.7 | 2.00 | 1.22 | 60.8 | 2.00 | 1.22 | 61.0 | 2.00 | 1.22 | 61.1 | 2.00 | 1.23 | 61.3 | 2.00 | 1.23 | 61.4 | 2.00 | 1.23 |
| 13.90 | 60.1 | 2.00 | 1.20 | 60.2 | 2.00 | 1.21 | 60.4 | 2.00 | 1.21 | 60.5 | 2.00 | 1.21 | 60.7 | 2.00 | 1.22 | 60.8 | 2.00 | 1.22 | 61.0 | 2.00 | 1.22 | 61.1 | 2.00 | 1.22 | 61.3 | 2.00 | 1.23 | 61.4 | 2.00 | 1.23 |
| 14.00 | 60.1 | 2.00 | 1.20 | 60.3 | 2.00 | 1.21 | 60.4 | 2.00 | 1.21 | 60.6 | 2.00 | 1.21 | 60.7 | 2.00 | 1.21 | 60.9 | 2.00 | 1.22 | 61.0 | 2.00 | 1.22 | 61.2 | 2.00 | 1.22 | 61.3 | 2.00 | 1.23 | 61.5 | 2.00 | 1.23 |
| 14.10 | 60.1 | 2.00 | 1.20 | 60.3 | 2.00 | 1.20 | 60.4 | 2.00 | 1.21 | 60.6 | 2.00 | 1.21 | 60.7 | 2.00 | 1.21 | 60.9 | 2.00 | 1.22 | 61.0 | 2.00 | 1.22 | 61.2 | 2.00 | 1.22 | 61.3 | 2.00 | 1.22 | 61.5 | 2.00 | 1.23 |
| 14.20 | 60.1 | 2.00 | 1.20 | 60.3 | 2.00 | 1.20 | 60.4 | 2.00 | 1.20 | 60.6 | 2.00 | 1.21 | 60.7 | 2.00 | 1.21 | 60.9 | 2.00 | 1.21 | 61.0 | 2.00 | 1.22 | 61.2 | 2.00 | 1.22 | 61.3 | 2.00 | 1.22 | 61.5 | 2.00 | 1.23 |
| 14.30 | 60.2 | 2.01 | 1.20 | 60.3 | 2.01 | 1.20 | 60.5 | 2.01 | 1.20 | 60.6 | 2.01 | 1.21 | 60.8 | 2.01 | 1.21 | 60.9 | 2.01 | 1.21 | 61.1 | 2.01 | 1.21 | 61.2 | 2.01 | 1.22 | 61.4 | 2.01 | 1.22 | 61.5 | 2.01 | 1.22 |
| 14.40 | 60.2 | 2.01 | 1.19 | 60.3 | 2.01 | 1.20 | 60.5 | 2.01 | 1.20 | 60.6 | 2.01 | 1.20 | 60.8 | 2.01 | 1.21 | 60.9 | 2.01 | 1.21 | 61.1 | 2.01 | 1.21 | 61.2 | 2.01 | 1.22 | 61.4 | 2.01 | 1.22 | 61.5 | 2.01 | 1.22 |
| 14.50 | 60.2 | 2.01 | 1.19 | 60.3 | 2.01 | 1.20 | 60.5 | 2.01 | 1.20 | 60.6 | 2.01 | 1.20 | 60.8 | 2.01 | 1.20 | 61.0 | 2.01 | 1.21 | 61.1 | 2.01 | 1.21 | 61.3 | 2.01 | 1.21 | 61.4 | 2.01 | 1.22 | 61.6 | 2.01 | 1.22 |
| 14.60 | 60.2 | 2.01 | 1.19 | 60.4 | 2.01 | 1.19 | 60.5 | 2.01 | 1.20 | 60.7 | 2.01 | 1.20 | 60.8 | 2.01 | 1.20 | 61.0 | 2.01 | 1.21 | 61.1 | 2.01 | 1.21 | 61.3 | 2.01 | 1.21 | 61.4 | 2.01 | 1.21 | 61.6 | 2.01 | 1.22 |
| 14.70 | 60.2 | 2.02 | 1.19 | 60.4 | 2.02 | 1.19 | 60.5 | 2.02 | 1.19 | 60.7 | 2.02 | 1.20 | 60.8 | 2.02 | 1.20 | 61.0 | 2.02 | 1.20 | 61.1 | 2.02 | 1.21 | 61.3 | 2.02 | 1.21 | 61.4 | 2.02 | 1.21 | 61.6 | 2.02 | 1.22 |
| 14.80 | 60.3 | 2.02 | 1.19 | 60.4 | 2.02 | 1.19 | 60.6 | 2.02 | 1.19 | 60.7 | 2.02 | 1.20 | 60.9 | 2.02 | 1.20 | 61.0 | 2.02 | 1.20 | 61.2 | 2.02 | 1.20 | 61.3 | 2.02 | 1.21 | 61.5 | 2.02 | 1.21 | 61.6 | 2.02 | 1.21 |
| 14.90 | 60.3 | 2.02 | 1.18 | 60.4 | 2.02 | 1.19 | 60.6 | 2.02 | 1.19 | 60.7 | 2.02 | 1.19 | 60.9 | 2.02 | 1.20 | 61.0 | 2.02 | 1.20 | 61.2 | 2.02 | 1.20 | 61.3 | 2.02 | 1.21 | 61.5 | 2.02 | 1.21 | 61.6 | 2.02 | 1.21 |
| 15.00 | 60.3 | 2.02 | 1.18 | 60.4 | 2.02 | 1.19 | 60.6 | 2.02 | 1.19 | 60.7 | 2.02 | 1.19 | 60.9 | 2.02 | 1.19 | 61.1 | 2.02 | 1.20 | 61.2 | 2.02 | 1.20 | 61.4 | 2.02 | 1.20 | 61.5 | 2.02 | 1.21 | 61.7 | 2.02 | 1.21 |
| 15.10 | 60.3 | 2.03 | 1.18 | 60.5 | 2.03 | 1.18 | 60.6 | 2.03 | 1.19 | 60.8 | 2.03 | 1.19 | 60.9 | 2.03 | 1.19 | 61.1 | 2.03 | 1.20 | 61.2 | 2.03 | 1.20 | 61.4 | 2.03 | 1.20 | 61.5 | 2.03 | 1.20 | 61.7 | 2.03 | 1.21 |
| 15.20 | 60.3 | 2.03 | 1.18 | 60.5 | 2.03 | 1.18 | 60.6 | 2.03 | 1.18 | 60.8 | 2.03 | 1.19 | 60.9 | 2.03 | 1.19 | 61.1 | 2.03 | 1.19 | 61.2 | 2.03 | 1.20 | 61.4 | 2.03 | 1.20 | 61.6 | 2.03 | 1.20 | 61.7 | 2.03 | 1.21 |
| 15.30 | 60.4 | 2.03 | 1.18 | 60.5 | 2.03 | 1.18 | 60.7 | 2.03 | 1.18 | 60.8 | 2.03 | 1.19 | 61.0 | 2.03 | 1.19 | 61.1 | 2.03 | 1.19 | 61.3 | 2.03 | 1.19 | 61.4 | 2.03 | 1.20 | 61.6 | 2.03 | 1.20 | 61.7 | 2.03 | 1.20 |
| 15.40 | 60.4 | 2.03 | 1.17 | 60.5 | 2.03 | 1.18 | 60.7 | 2.03 | 1.18 | 60.8 | 2.03 | 1.18 | 61.0 | 2.03 | 1.19 | 61.1 | 2.03 | 1.19 | 61.3 | 2.03 | 1.19 | 61.4 | 2.03 | 1.20 | 61.6 | 2.03 | 1.20 | 61.7 | 2.03 | 1.20 |
| 15.50 | 60.4 | 2.04 | 1.17 | 60.5 | 2.04 | 1.18 | 60.7 | 2.04 | 1.18 | 60.9 | 2.04 | 1.18 | 61.0 | 2.04 | 1.18 | 61.2 | 2.04 | 1.19 | 61.3 | 2.04 | 1.19 | 61.5 | 2.04 | 1.19 | 61.6 | 2.04 | 1.20 | 61.8 | 2.04 | 1.20 |
| 15.60 | 60.4 | 2.04 | 1.17 | 60.6 | 2.04 | 1.17 | 60.7 | 2.04 | 1.18 | 60.9 | 2.04 | 1.18 | 61.0 | 2.04 | 1.18 | 61.2 | 2.04 | 1.19 | 61.3 | 2.04 | 1.19 | 61.5 | 2.04 | 1.19 | 61.6 | 2.04 | 1.19 | 61.8 | 2.04 | 1.20 |
| 15.70 | 60.4 | 2.04 | 1.17 | 60.6 | 2.04 | 1.17 | 60.7 | 2.04 | 1.17 | 60.9 | 2.04 | 1.18 | 61.0 | 2.04 | 1.18 | 61.2 | 2.04 | 1.18 | 61.4 | 2.04 | 1.19 | 61.5 | 2.04 | 1.19 | 61.7 | 2.04 | 1.19 | 61.8 | 2.04 | 1.20 |
| 15.80 | 60.5 | 2.04 | 1.17 | 60.6 | 2.04 | 1.17 | 60.8 | 2.04 | 1.17 | 60.9 | 2.04 | 1.18 | 61.1 | 2.04 | 1.18 | 61.2 | 2.04 | 1.18 | 61.4 | 2.04 | 1.18 | 61.5 | 2.04 | 1.19 | 61.7 | 2.04 | 1.19 | 61.8 | 2.04 | 1.19 |
| 15.90 | 60.5 | 2.05 | 1.16 | 60.6 | 2.05 | 1.17 | 60.8 | 2.05 | 1.17 | 60.9 | 2.05 | 1.17 | 61.1 | 2.05 | 1.18 | 61.2 | 2.05 | 1.18 | 61.4 | 2.05 | 1.18 | 61.5 | 2.05 | 1.19 | 61.7 | 2.05 | 1.19 | 61.9 | 2.05 | 1.19 |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 2.0; Water (ml) = (% Absorption x 2.0 / 100) + (2.0 - sample weight)

## 2-gram Mixograph: Absorption, Flour and Water Amount Table
## (12.0 - 12.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 12.00 | | | 12.10 | | | 12.20 | | | 12.30 | | | 12.40 | | | 12.50 | | | 12.60 | | | 12.70 | | | 12.80 | | | 12.90 | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml |
| 9.00 | 60.6 | 1.89 | 1.32 | 60.8 | 1.89 | 1.32 | 60.9 | 1.89 | 1.33 | 61.0 | 1.89 | 1.33 | 61.2 | 1.89 | 1.33 | 61.3 | 1.89 | 1.34 | 61.5 | 1.89 | 1.34 | 61.6 | 1.89 | 1.34 | 61.7 | 1.89 | 1.34 | 61.9 | 1.89 | 1.35 |
| 9.10 | 60.6 | 1.89 | 1.32 | 60.8 | 1.89 | 1.32 | 60.9 | 1.89 | 1.33 | 61.1 | 1.89 | 1.33 | 61.2 | 1.89 | 1.33 | 61.3 | 1.89 | 1.33 | 61.5 | 1.89 | 1.34 | 61.6 | 1.89 | 1.34 | 61.8 | 1.89 | 1.34 | 61.9 | 1.89 | 1.35 |
| 9.20 | 60.6 | 1.89 | 1.32 | 60.8 | 1.89 | 1.32 | 60.9 | 1.89 | 1.32 | 61.1 | 1.89 | 1.33 | 61.2 | 1.89 | 1.33 | 61.4 | 1.89 | 1.33 | 61.5 | 1.89 | 1.34 | 61.6 | 1.89 | 1.34 | 61.8 | 1.89 | 1.34 | 61.9 | 1.89 | 1.34 |
| 9.30 | 60.7 | 1.90 | 1.32 | 60.8 | 1.90 | 1.32 | 61.0 | 1.90 | 1.32 | 61.1 | 1.90 | 1.33 | 61.2 | 1.90 | 1.33 | 61.4 | 1.90 | 1.33 | 61.5 | 1.90 | 1.33 | 61.7 | 1.90 | 1.34 | 61.8 | 1.90 | 1.34 | 61.9 | 1.90 | 1.34 |
| 9.40 | 60.7 | 1.90 | 1.32 | 60.8 | 1.90 | 1.32 | 61.0 | 1.90 | 1.32 | 61.1 | 1.90 | 1.32 | 61.3 | 1.90 | 1.33 | 61.4 | 1.90 | 1.33 | 61.5 | 1.90 | 1.33 | 61.7 | 1.90 | 1.34 | 61.8 | 1.90 | 1.34 | 62.0 | 1.90 | 1.34 |
| 9.50 | 60.7 | 1.90 | 1.31 | 60.8 | 1.90 | 1.32 | 61.0 | 1.90 | 1.32 | 61.1 | 1.90 | 1.32 | 61.3 | 1.90 | 1.32 | 61.4 | 1.90 | 1.33 | 61.6 | 1.90 | 1.33 | 61.7 | 1.90 | 1.33 | 61.8 | 1.90 | 1.34 | 62.0 | 1.90 | 1.34 |
| 9.60 | 60.7 | 1.90 | 1.31 | 60.9 | 1.90 | 1.31 | 61.0 | 1.90 | 1.32 | 61.2 | 1.90 | 1.32 | 61.3 | 1.90 | 1.32 | 61.4 | 1.90 | 1.33 | 61.6 | 1.90 | 1.33 | 61.7 | 1.90 | 1.33 | 61.9 | 1.90 | 1.33 | 62.0 | 1.90 | 1.34 |
| 9.70 | 60.7 | 1.90 | 1.31 | 60.9 | 1.90 | 1.31 | 61.0 | 1.90 | 1.32 | 61.2 | 1.90 | 1.32 | 61.3 | 1.90 | 1.32 | 61.5 | 1.90 | 1.32 | 61.6 | 1.90 | 1.33 | 61.7 | 1.90 | 1.33 | 61.9 | 1.90 | 1.33 | 62.0 | 1.90 | 1.34 |
| 9.80 | 60.8 | 1.91 | 1.31 | 60.9 | 1.91 | 1.31 | 61.0 | 1.91 | 1.31 | 61.2 | 1.91 | 1.32 | 61.3 | 1.91 | 1.32 | 61.5 | 1.91 | 1.32 | 61.6 | 1.91 | 1.33 | 61.8 | 1.91 | 1.33 | 61.9 | 1.91 | 1.33 | 62.0 | 1.91 | 1.33 |
| 9.90 | 60.8 | 1.91 | 1.31 | 60.9 | 1.91 | 1.31 | 61.1 | 1.91 | 1.31 | 61.2 | 1.91 | 1.32 | 61.4 | 1.91 | 1.32 | 61.5 | 1.91 | 1.32 | 61.6 | 1.91 | 1.32 | 61.8 | 1.91 | 1.33 | 61.9 | 1.91 | 1.33 | 62.1 | 1.91 | 1.33 |
| 10.00 | 60.8 | 1.91 | 1.30 | 60.9 | 1.91 | 1.31 | 61.1 | 1.91 | 1.31 | 61.2 | 1.91 | 1.31 | 61.4 | 1.91 | 1.32 | 61.5 | 1.91 | 1.32 | 61.7 | 1.91 | 1.32 | 61.8 | 1.91 | 1.32 | 61.9 | 1.91 | 1.33 | 62.1 | 1.91 | 1.33 |
| 10.10 | 60.8 | 1.91 | 1.30 | 61.0 | 1.91 | 1.31 | 61.1 | 1.91 | 1.31 | 61.2 | 1.91 | 1.31 | 61.4 | 1.91 | 1.31 | 61.5 | 1.91 | 1.32 | 61.7 | 1.91 | 1.32 | 61.8 | 1.91 | 1.32 | 62.0 | 1.91 | 1.33 | 62.1 | 1.91 | 1.33 |
| 10.20 | 60.8 | 1.92 | 1.30 | 61.0 | 1.92 | 1.30 | 61.1 | 1.92 | 1.31 | 61.3 | 1.92 | 1.31 | 61.4 | 1.92 | 1.31 | 61.6 | 1.92 | 1.32 | 61.7 | 1.92 | 1.32 | 61.8 | 1.92 | 1.32 | 62.0 | 1.92 | 1.32 | 62.1 | 1.92 | 1.33 |
| 10.30 | 60.9 | 1.92 | 1.30 | 61.0 | 1.92 | 1.30 | 61.1 | 1.92 | 1.31 | 61.3 | 1.92 | 1.31 | 61.4 | 1.92 | 1.31 | 61.6 | 1.92 | 1.31 | 61.7 | 1.92 | 1.32 | 61.9 | 1.92 | 1.32 | 62.0 | 1.92 | 1.32 | 62.2 | 1.92 | 1.33 |
| 10.40 | 60.9 | 1.92 | 1.30 | 61.0 | 1.92 | 1.30 | 61.2 | 1.92 | 1.30 | 61.3 | 1.92 | 1.31 | 61.5 | 1.92 | 1.31 | 61.6 | 1.92 | 1.31 | 61.7 | 1.92 | 1.32 | 61.9 | 1.92 | 1.32 | 62.0 | 1.92 | 1.32 | 62.2 | 1.92 | 1.32 |
| 10.50 | 60.9 | 1.92 | 1.30 | 61.0 | 1.92 | 1.30 | 61.2 | 1.92 | 1.30 | 61.3 | 1.92 | 1.30 | 61.5 | 1.92 | 1.31 | 61.6 | 1.92 | 1.31 | 61.8 | 1.92 | 1.31 | 61.9 | 1.92 | 1.32 | 62.0 | 1.92 | 1.32 | 62.2 | 1.92 | 1.32 |
| 10.60 | 60.9 | 1.92 | 1.29 | 61.1 | 1.92 | 1.30 | 61.2 | 1.92 | 1.30 | 61.3 | 1.92 | 1.30 | 61.5 | 1.92 | 1.31 | 61.6 | 1.92 | 1.31 | 61.8 | 1.92 | 1.31 | 61.9 | 1.92 | 1.31 | 62.1 | 1.92 | 1.32 | 62.2 | 1.92 | 1.32 |
| 10.70 | 60.9 | 1.93 | 1.29 | 61.1 | 1.93 | 1.30 | 61.2 | 1.93 | 1.30 | 61.4 | 1.93 | 1.30 | 61.5 | 1.93 | 1.30 | 61.7 | 1.93 | 1.31 | 61.8 | 1.93 | 1.31 | 61.9 | 1.93 | 1.31 | 62.1 | 1.93 | 1.32 | 62.2 | 1.93 | 1.32 |
| 10.80 | 61.0 | 1.93 | 1.29 | 60.5 | 1.93 | 1.28 | 61.2 | 1.93 | 1.30 | 61.4 | 1.93 | 1.30 | 61.5 | 1.93 | 1.30 | 61.7 | 1.93 | 1.31 | 61.2 | 1.93 | 1.30 | 62.0 | 1.93 | 1.31 | 62.1 | 1.93 | 1.31 | 62.3 | 1.93 | 1.32 |
| 10.90 | 61.0 | 1.93 | 1.29 | 61.1 | 1.93 | 1.29 | 61.3 | 1.93 | 1.29 | 61.4 | 1.93 | 1.30 | 61.6 | 1.93 | 1.30 | 61.7 | 1.93 | 1.30 | 61.8 | 1.93 | 1.31 | 62.0 | 1.93 | 1.31 | 62.1 | 1.93 | 1.31 | 62.3 | 1.93 | 1.32 |
| 11.00 | 61.0 | 1.93 | 1.29 | 61.1 | 1.93 | 1.29 | 61.3 | 1.93 | 1.29 | 61.4 | 1.93 | 1.30 | 61.6 | 1.93 | 1.30 | 61.7 | 1.93 | 1.30 | 61.9 | 1.93 | 1.30 | 62.0 | 1.93 | 1.31 | 62.2 | 1.93 | 1.31 | 62.3 | 1.93 | 1.31 |
| 11.10 | 61.0 | 1.93 | 1.29 | 61.2 | 1.93 | 1.29 | 61.3 | 1.93 | 1.29 | 61.4 | 1.93 | 1.29 | 61.6 | 1.93 | 1.30 | 61.7 | 1.93 | 1.30 | 61.9 | 1.93 | 1.30 | 62.0 | 1.93 | 1.31 | 62.2 | 1.93 | 1.31 | 62.3 | 1.93 | 1.31 |
| 11.20 | 61.0 | 1.94 | 1.28 | 61.2 | 1.94 | 1.29 | 61.3 | 1.94 | 1.29 | 61.5 | 1.94 | 1.29 | 61.6 | 1.94 | 1.30 | 61.8 | 1.94 | 1.30 | 61.9 | 1.94 | 1.30 | 62.0 | 1.94 | 1.30 | 62.2 | 1.94 | 1.31 | 62.3 | 1.94 | 1.31 |
| 11.30 | 61.1 | 1.94 | 1.28 | 61.2 | 1.94 | 1.28 | 61.3 | 1.94 | 1.29 | 61.5 | 1.94 | 1.29 | 61.6 | 1.94 | 1.29 | 61.8 | 1.94 | 1.30 | 61.9 | 1.94 | 1.30 | 62.1 | 1.94 | 1.30 | 62.2 | 1.94 | 1.31 | 62.4 | 1.94 | 1.31 |
| 11.40 | 61.1 | 1.94 | 1.28 | 61.2 | 1.94 | 1.28 | 61.4 | 1.94 | 1.29 | 61.5 | 1.94 | 1.29 | 61.7 | 1.94 | 1.29 | 61.8 | 1.94 | 1.29 | 61.9 | 1.94 | 1.30 | 62.1 | 1.94 | 1.30 | 62.2 | 1.94 | 1.30 | 62.4 | 1.94 | 1.31 |
| 11.50 | 61.1 | 1.94 | 1.28 | 61.2 | 1.94 | 1.28 | 61.4 | 1.94 | 1.28 | 61.5 | 1.94 | 1.29 | 61.7 | 1.94 | 1.29 | 61.8 | 1.94 | 1.29 | 62.0 | 1.94 | 1.30 | 62.1 | 1.94 | 1.30 | 62.3 | 1.94 | 1.30 | 62.4 | 1.94 | 1.30 |
| 11.60 | 61.1 | 1.95 | 1.28 | 61.3 | 1.95 | 1.28 | 61.4 | 1.95 | 1.28 | 61.5 | 1.95 | 1.29 | 61.7 | 1.95 | 1.29 | 61.8 | 1.95 | 1.29 | 62.0 | 1.95 | 1.29 | 62.1 | 1.95 | 1.30 | 62.3 | 1.95 | 1.30 | 62.4 | 1.95 | 1.30 |
| 11.70 | 61.1 | 1.95 | 1.27 | 61.3 | 1.95 | 1.28 | 61.4 | 1.95 | 1.28 | 61.6 | 1.95 | 1.28 | 61.7 | 1.95 | 1.29 | 61.9 | 1.95 | 1.29 | 62.0 | 1.95 | 1.29 | 62.2 | 1.95 | 1.30 | 62.3 | 1.95 | 1.30 | 62.4 | 1.95 | 1.30 |
| 11.80 | 61.2 | 1.95 | 1.27 | 61.3 | 1.95 | 1.28 | 61.4 | 1.95 | 1.28 | 61.6 | 1.95 | 1.28 | 61.7 | 1.95 | 1.28 | 61.9 | 1.95 | 1.29 | 62.0 | 1.95 | 1.29 | 62.2 | 1.95 | 1.29 | 62.3 | 1.95 | 1.30 | 62.5 | 1.95 | 1.30 |
| 11.90 | 61.2 | 1.95 | 1.27 | 61.3 | 1.95 | 1.27 | 61.5 | 1.95 | 1.28 | 61.6 | 1.95 | 1.28 | 61.8 | 1.95 | 1.28 | 61.9 | 1.95 | 1.29 | 62.0 | 1.95 | 1.29 | 62.2 | 1.95 | 1.29 | 62.3 | 1.95 | 1.29 | 62.5 | 1.95 | 1.30 |
| 12.00 | 61.2 | 1.95 | 1.27 | 61.3 | 1.95 | 1.27 | 61.5 | 1.95 | 1.28 | 61.6 | 1.95 | 1.28 | 61.8 | 1.95 | 1.28 | 61.9 | 1.95 | 1.28 | 62.1 | 1.95 | 1.29 | 62.2 | 1.95 | 1.29 | 62.4 | 1.95 | 1.29 | 62.5 | 1.95 | 1.30 |
| 12.10 | 61.2 | 1.96 | 1.27 | 61.4 | 1.96 | 1.27 | 61.5 | 1.96 | 1.27 | 61.7 | 1.96 | 1.28 | 61.8 | 1.96 | 1.28 | 61.9 | 1.96 | 1.28 | 62.1 | 1.96 | 1.29 | 62.2 | 1.96 | 1.29 | 62.4 | 1.96 | 1.29 | 62.5 | 1.96 | 1.29 |
| 12.30 | 61.3 | 1.96 | 1.26 | 61.4 | 1.96 | 1.27 | 61.5 | 1.96 | 1.27 | 61.7 | 1.96 | 1.27 | 61.8 | 1.96 | 1.28 | 62.0 | 1.96 | 1.28 | 62.1 | 1.96 | 1.28 | 62.3 | 1.96 | 1.28 | 62.4 | 1.96 | 1.29 | 62.6 | 1.96 | 1.29 |
| 12.30 | 61.3 | 1.96 | 1.26 | 61.4 | 1.96 | 1.27 | 61.5 | 1.96 | 1.27 | 61.7 | 1.96 | 1.27 | 61.8 | 1.96 | 1.28 | 62.0 | 1.96 | 1.28 | 62.1 | 1.96 | 1.28 | 62.3 | 1.96 | 1.28 | 62.4 | 1.96 | 1.29 | 62.6 | 1.96 | 1.29 |
| 12.40 | 61.3 | 1.96 | 1.26 | 61.4 | 1.96 | 1.26 | 61.6 | 1.96 | 1.27 | 61.7 | 1.96 | 1.27 | 61.9 | 1.96 | 1.27 | 62.0 | 1.96 | 1.28 | 62.2 | 1.96 | 1.28 | 62.3 | 1.96 | 1.28 | 62.4 | 1.96 | 1.29 | 62.6 | 1.96 | 1.29 |
| 12.50 | 61.3 | 1.97 | 1.26 | 61.4 | 1.97 | 1.26 | 61.6 | 1.97 | 1.27 | 61.7 | 1.97 | 1.27 | 61.9 | 1.97 | 1.27 | 62.0 | 1.97 | 1.27 | 62.2 | 1.97 | 1.28 | 62.3 | 1.97 | 1.28 | 62.5 | 1.97 | 1.28 | 62.6 | 1.97 | 1.29 |
| 12.60 | 61.3 | 1.97 | 1.26 | 61.5 | 1.97 | 1.26 | 61.6 | 1.97 | 1.26 | 61.8 | 1.97 | 1.27 | 61.9 | 1.97 | 1.27 | 62.0 | 1.97 | 1.27 | 62.2 | 1.97 | 1.28 | 62.3 | 1.97 | 1.28 | 62.5 | 1.97 | 1.28 | 62.6 | 1.97 | 1.28 |
| 12.70 | 61.3 | 1.97 | 1.26 | 61.5 | 1.97 | 1.26 | 61.6 | 1.97 | 1.26 | 61.8 | 1.97 | 1.27 | 61.9 | 1.97 | 1.27 | 62.1 | 1.97 | 1.27 | 62.2 | 1.97 | 1.27 | 62.4 | 1.97 | 1.28 | 62.5 | 1.97 | 1.28 | 62.7 | 1.97 | 1.28 |
| 12.80 | 61.4 | 1.97 | 1.25 | 61.5 | 1.97 | 1.26 | 61.6 | 1.97 | 1.26 | 61.8 | 1.97 | 1.26 | 61.9 | 1.97 | 1.27 | 62.1 | 1.97 | 1.27 | 62.2 | 1.97 | 1.27 | 62.4 | 1.97 | 1.28 | 62.5 | 1.97 | 1.28 | 62.7 | 1.97 | 1.28 |
| 12.90 | 61.4 | 1.97 | 1.25 | 61.5 | 1.97 | 1.26 | 61.7 | 1.97 | 1.26 | 61.8 | 1.97 | 1.26 | 62.0 | 1.97 | 1.26 | 62.1 | 1.97 | 1.27 | 62.3 | 1.97 | 1.27 | 62.4 | 1.97 | 1.27 | 62.6 | 1.97 | 1.28 | 62.7 | 1.97 | 1.28 |
| 13.00 | 61.4 | 1.98 | 1.25 | 61.5 | 1.98 | 1.25 | 61.7 | 1.98 | 1.26 | 61.8 | 1.98 | 1.26 | 62.0 | 1.98 | 1.26 | 62.1 | 1.98 | 1.27 | 62.3 | 1.98 | 1.27 | 62.4 | 1.98 | 1.27 | 62.6 | 1.98 | 1.27 | 62.7 | 1.98 | 1.28 |
| 13.10 | 61.4 | 1.98 | 1.25 | 61.6 | 1.98 | 1.25 | 61.7 | 1.98 | 1.25 | 61.9 | 1.98 | 1.26 | 62.0 | 1.98 | 1.26 | 62.2 | 1.98 | 1.26 | 62.3 | 1.98 | 1.27 | 62.5 | 1.98 | 1.27 | 62.6 | 1.98 | 1.27 | 62.7 | 1.98 | 1.28 |
| 13.20 | 61.4 | 1.98 | 1.25 | 61.6 | 1.98 | 1.25 | 61.7 | 1.98 | 1.25 | 61.9 | 1.98 | 1.26 | 62.0 | 1.98 | 1.26 | 62.2 | 1.98 | 1.26 | 62.3 | 1.98 | 1.26 | 62.5 | 1.98 | 1.27 | 62.6 | 1.98 | 1.27 | 62.8 | 1.98 | 1.27 |
| 13.30 | 61.5 | 1.98 | 1.25 | 61.6 | 1.98 | 1.25 | 61.8 | 1.98 | 1.25 | 61.9 | 1.98 | 1.25 | 62.0 | 1.98 | 1.26 | 62.2 | 1.98 | 1.26 | 62.3 | 1.98 | 1.26 | 62.5 | 1.98 | 1.27 | 62.6 | 1.98 | 1.27 | 62.8 | 1.98 | 1.27 |
| 13.40 | 61.5 | 1.99 | 1.24 | 61.6 | 1.99 | 1.25 | 61.8 | 1.99 | 1.25 | 61.9 | 1.99 | 1.25 | 62.1 | 1.99 | 1.26 | 62.2 | 1.99 | 1.26 | 62.4 | 1.99 | 1.26 | 62.5 | 1.99 | 1.26 | 62.7 | 1.99 | 1.27 | 62.8 | 1.99 | 1.27 |
| 13.50 | 61.5 | 1.99 | 1.24 | 61.6 | 1.99 | 1.24 | 61.8 | 1.99 | 1.25 | 61.9 | 1.99 | 1.25 | 62.1 | 1.99 | 1.25 | 62.2 | 1.99 | 1.26 | 62.4 | 1.99 | 1.26 | 62.5 | 1.99 | 1.26 | 62.7 | 1.99 | 1.27 | 62.8 | 1.99 | 1.27 |
| 13.60 | 61.5 | 1.99 | 1.24 | 61.7 | 1.99 | 1.24 | 61.8 | 1.99 | 1.25 | 62.0 | 1.99 | 1.25 | 62.1 | 1.99 | 1.25 | 62.3 | 1.99 | 1.25 | 62.4 | 1.99 | 1.26 | 62.6 | 1.99 | 1.26 | 62.7 | 1.99 | 1.26 | 62.9 | 1.99 | 1.27 |
| 13.70 | 61.5 | 1.99 | 1.24 | 61.7 | 1.99 | 1.24 | 61.8 | 1.99 | 1.24 | 62.0 | 1.99 | 1.25 | 62.1 | 1.99 | 1.25 | 62.3 | 1.99 | 1.25 | 62.4 | 1.99 | 1.26 | 62.6 | 1.99 | 1.26 | 62.7 | 1.99 | 1.26 | 62.9 | 1.99 | 1.26 |
| 13.80 | 61.6 | 2.00 | 1.24 | 61.7 | 2.00 | 1.24 | 61.9 | 2.00 | 1.24 | 62.0 | 2.00 | 1.24 | 62.2 | 2.00 | 1.25 | 62.3 | 2.00 | 1.25 | 62.5 | 2.00 | 1.25 | 62.6 | 2.00 | 1.26 | 62.8 | 2.00 | 1.26 | 62.9 | 2.00 | 1.26 |
| 13.90 | 61.6 | 2.00 | 1.23 | 61.7 | 2.00 | 1.24 | 61.9 | 2.00 | 1.24 | 62.0 | 2.00 | 1.24 | 62.2 | 2.00 | 1.25 | 62.3 | 2.00 | 1.25 | 62.5 | 2.00 | 1.25 | 62.6 | 2.00 | 1.25 | 62.8 | 2.00 | 1.26 | 62.9 | 2.00 | 1.26 |
| 14.00 | 61.6 | 2.00 | 1.23 | 61.8 | 2.00 | 1.24 | 61.9 | 2.00 | 1.24 | 62.1 | 2.00 | 1.24 | 62.2 | 2.00 | 1.24 | 62.4 | 2.00 | 1.25 | 62.5 | 2.00 | 1.25 | 62.7 | 2.00 | 1.25 | 62.8 | 2.00 | 1.26 | 63.0 | 2.00 | 1.26 |
| 14.10 | 61.6 | 2.00 | 1.23 | 61.8 | 2.00 | 1.23 | 61.9 | 2.00 | 1.24 | 62.1 | 2.00 | 1.24 | 62.2 | 2.00 | 1.24 | 62.4 | 2.00 | 1.25 | 62.5 | 2.00 | 1.25 | 62.7 | 2.00 | 1.25 | 62.8 | 2.00 | 1.25 | 63.0 | 2.00 | 1.26 |
| 14.20 | 61.6 | 2.00 | 1.23 | 61.8 | 2.00 | 1.23 | 61.9 | 2.00 | 1.23 | 62.1 | 2.00 | 1.24 | 62.2 | 2.00 | 1.24 | 62.4 | 2.00 | 1.24 | 62.5 | 2.00 | 1.25 | 62.7 | 2.00 | 1.25 | 62.8 | 2.00 | 1.25 | 63.0 | 2.00 | 1.26 |
| 14.30 | 61.7 | 2.01 | 1.23 | 61.8 | 2.01 | 1.23 | 62.0 | 2.01 | 1.23 | 62.1 | 2.01 | 1.24 | 62.3 | 2.01 | 1.24 | 62.4 | 2.01 | 1.24 | 62.6 | 2.01 | 1.24 | 62.7 | 2.01 | 1.25 | 62.9 | 2.01 | 1.25 | 63.0 | 2.01 | 1.25 |
| 14.40 | 61.7 | 2.01 | 1.22 | 61.8 | 2.01 | 1.23 | 62.0 | 2.01 | 1.23 | 62.1 | 2.01 | 1.23 | 62.3 | 2.01 | 1.24 | 62.4 | 2.01 | 1.24 | 62.6 | 2.01 | 1.24 | 62.7 | 2.01 | 1.25 | 62.9 | 2.01 | 1.25 | 63.0 | 2.01 | 1.25 |
| 14.50 | 61.7 | 2.01 | 1.22 | 61.9 | 2.01 | 1.23 | 62.0 | 2.01 | 1.23 | 62.2 | 2.01 | 1.23 | 62.3 | 2.01 | 1.23 | 62.5 | 2.01 | 1.24 | 62.6 | 2.01 | 1.24 | 62.8 | 2.01 | 1.24 | 62.9 | 2.01 | 1.25 | 63.1 | 2.01 | 1.25 |
| 14.60 | 61.7 | 2.01 | 1.22 | 61.9 | 2.01 | 1.22 | 62.0 | 2.01 | 1.23 | 62.2 | 2.01 | 1.23 | 62.3 | 2.01 | 1.23 | 62.5 | 2.01 | 1.24 | 62.6 | 2.01 | 1.24 | 62.8 | 2.01 | 1.24 | 62.9 | 2.01 | 1.24 | 63.1 | 2.01 | 1.25 |
| 14.70 | 61.7 | 2.02 | 1.22 | 61.9 | 2.02 | 1.22 | 62.1 | 2.02 | 1.22 | 62.2 | 2.02 | 1.23 | 62.4 | 2.02 | 1.23 | 62.5 | 2.02 | 1.23 | 62.7 | 2.02 | 1.24 | 62.8 | 2.02 | 1.24 | 63.0 | 2.02 | 1.24 | 63.1 | 2.02 | 1.25 |
| 14.80 | 61.8 | 2.02 | 1.22 | 61.9 | 2.02 | 1.22 | 62.1 | 2.02 | 1.22 | 62.2 | 2.02 | 1.23 | 62.4 | 2.02 | 1.23 | 62.5 | 2.02 | 1.23 | 62.7 | 2.02 | 1.23 | 62.8 | 2.02 | 1.24 | 63.0 | 2.02 | 1.24 | 63.1 | 2.02 | 1.24 |
| 14.90 | 61.8 | 2.02 | 1.21 | 61.9 | 2.02 | 1.22 | 62.1 | 2.02 | 1.22 | 62.2 | 2.02 | 1.22 | 62.4 | 2.02 | 1.23 | 62.5 | 2.02 | 1.23 | 62.7 | 2.02 | 1.23 | 62.9 | 2.02 | 1.24 | 63.0 | 2.02 | 1.24 | 63.2 | 2.02 | 1.24 |
| 15.00 | 61.8 | 2.02 | 1.21 | 62.0 | 2.02 | 1.22 | 62.1 | 2.02 | 1.22 | 62.3 | 2.02 | 1.22 | 62.4 | 2.02 | 1.22 | 62.6 | 2.02 | 1.23 | 62.7 | 2.02 | 1.23 | 62.9 | 2.02 | 1.23 | 63.0 | 2.02 | 1.24 | 63.2 | 2.02 | 1.24 |
| 15.10 | 61.8 | 2.03 | 1.21 | 62.0 | 2.03 | 1.21 | 62.1 | 2.03 | 1.22 | 62.3 | 2.03 | 1.22 | 62.4 | 2.03 | 1.22 | 62.6 | 2.03 | 1.23 | 62.7 | 2.03 | 1.23 | 62.9 | 2.03 | 1.23 | 63.0 | 2.03 | 1.24 | 63.2 | 2.03 | 1.24 |
| 15.20 | 61.9 | 2.03 | 1.21 | 62.0 | 2.03 | 1.21 | 62.2 | 2.03 | 1.21 | 62.3 | 2.03 | 1.22 | 62.5 | 2.03 | 1.22 | 62.6 | 2.03 | 1.22 | 62.8 | 2.03 | 1.23 | 62.9 | 2.03 | 1.23 | 63.1 | 2.03 | 1.23 | 63.2 | 2.03 | 1.24 |
| 15.30 | 61.9 | 2.03 | 1.21 | 62.0 | 2.03 | 1.21 | 62.2 | 2.03 | 1.21 | 62.3 | 2.03 | 1.22 | 62.5 | 2.03 | 1.22 | 62.6 | 2.03 | 1.22 | 62.8 | 2.03 | 1.23 | 62.9 | 2.03 | 1.23 | 63.1 | 2.03 | 1.23 | 63.2 | 2.03 | 1.23 |
| 15.40 | 61.9 | 2.03 | 1.20 | 62.1 | 2.03 | 1.21 | 62.2 | 2.03 | 1.21 | 62.4 | 2.03 | 1.21 | 62.5 | 2.03 | 1.22 | 62.7 | 2.03 | 1.22 | 62.8 | 2.03 | 1.22 | 63.0 | 2.03 | 1.23 | 63.1 | 2.03 | 1.23 | 63.3 | 2.03 | 1.23 |
| 15.50 | 61.9 | 2.04 | 1.20 | 62.1 | 2.04 | 1.21 | 62.2 | 2.04 | 1.21 | 62.4 | 2.04 | 1.21 | 62.5 | 2.04 | 1.22 | 62.7 | 2.04 | 1.22 | 62.8 | 2.04 | 1.22 | 63.0 | 2.04 | 1.22 | 63.1 | 2.04 | 1.23 | 63.3 | 2.04 | 1.23 |
| 15.60 | 61.9 | 2.04 | 1.20 | 62.1 | 2.04 | 1.20 | 62.2 | 2.04 | 1.21 | 62.4 | 2.04 | 1.21 | 62.6 | 2.04 | 1.21 | 62.7 | 2.04 | 1.22 | 62.9 | 2.04 | 1.22 | 63.0 | 2.04 | 1.22 | 63.2 | 2.04 | 1.23 | 63.3 | 2.04 | 1.23 |
| 15.70 | 62.0 | 2.04 | 1.20 | 62.1 | 2.04 | 1.20 | 62.3 | 2.04 | 1.21 | 62.4 | 2.04 | 1.21 | 62.6 | 2.04 | 1.21 | 62.7 | 2.04 | 1.21 | 62.9 | 2.04 | 1.22 | 63.0 | 2.04 | 1.22 | 63.2 | 2.04 | 1.22 | 63.3 | 2.04 | 1.23 |
| 15.80 | 62.0 | 2.04 | 1.20 | 62.1 | 2.04 | 1.20 | 62.3 | 2.04 | 1.20 | 62.4 | 2.04 | 1.21 | 62.6 | 2.04 | 1.21 | 62.8 | 2.04 | 1.21 | 62.9 | 2.04 | 1.22 | 63.1 | 2.04 | 1.22 | 63.2 | 2.04 | 1.22 | 63.4 | 2.04 | 1.22 |
| 15.90 | 62.0 | 2.05 | 1.19 | 62.2 | 2.05 | 1.20 | 62.3 | 2.05 | 1.20 | 62.5 | 2.05 | 1.20 | 62.6 | 2.05 | 1.21 | 62.8 | 2.05 | 1.21 | 62.9 | 2.05 | 1.21 | 63.1 | 2.05 | 1.22 | 63.2 | 2.05 | 1.22 | 63.4 | 2.05 | 1.22 |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 2.0; Water (ml) = (% Absorption x 2.0 / 100) + (2.0 - sample weight)

## 2-gram Mixograph: Absorption, Flour and Water Amount Table
## (13.0 - 13.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 13.00 | | | 13.10 | | | 13.20 | | | 13.30 | | | 13.40 | | | 13.50 | | | 13.60 | | | 13.70 | | | 13.80 | | | 13.90 | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml |
| 9.00 | 62.0 | 1.89 | 1.35 | 62.2 | 1.89 | 1.35 | 62.3 | 1.89 | 1.36 | 62.5 | 1.89 | 1.36 | 62.6 | 1.89 | 1.36 | 62.7 | 1.89 | 1.36 | 62.9 | 1.89 | 1.37 | 63.0 | 1.89 | 1.37 | 63.2 | 1.89 | 1.37 | 63.3 | 1.89 | 1.38 |
| 9.10 | 62.0 | 1.89 | 1.35 | 62.2 | 1.89 | 1.35 | 62.3 | 1.89 | 1.35 | 62.5 | 1.89 | 1.36 | 62.6 | 1.89 | 1.36 | 62.8 | 1.89 | 1.36 | 62.9 | 1.89 | 1.37 | 63.0 | 1.89 | 1.37 | 63.2 | 1.89 | 1.37 | 63.3 | 1.89 | 1.37 |
| 9.20 | 62.1 | 1.89 | 1.35 | 62.2 | 1.89 | 1.35 | 62.4 | 1.89 | 1.35 | 62.5 | 1.89 | 1.36 | 62.6 | 1.89 | 1.36 | 62.8 | 1.89 | 1.36 | 62.9 | 1.89 | 1.36 | 63.1 | 1.89 | 1.37 | 63.2 | 1.89 | 1.37 | 63.3 | 1.89 | 1.37 |
| 9.30 | 62.1 | 1.90 | 1.35 | 62.2 | 1.90 | 1.35 | 62.4 | 1.90 | 1.35 | 62.5 | 1.90 | 1.35 | 62.7 | 1.90 | 1.36 | 62.8 | 1.90 | 1.36 | 62.9 | 1.90 | 1.36 | 63.1 | 1.90 | 1.37 | 63.2 | 1.90 | 1.37 | 63.4 | 1.90 | 1.37 |
| 9.40 | 62.1 | 1.90 | 1.34 | 62.3 | 1.90 | 1.35 | 62.4 | 1.90 | 1.35 | 62.5 | 1.90 | 1.35 | 62.7 | 1.90 | 1.36 | 62.8 | 1.90 | 1.36 | 63.0 | 1.90 | 1.36 | 63.1 | 1.90 | 1.36 | 63.2 | 1.90 | 1.37 | 63.4 | 1.90 | 1.37 |
| 9.50 | 62.1 | 1.90 | 1.34 | 62.3 | 1.90 | 1.34 | 62.4 | 1.90 | 1.35 | 62.6 | 1.90 | 1.35 | 62.7 | 1.90 | 1.35 | 62.8 | 1.90 | 1.36 | 63.0 | 1.90 | 1.36 | 63.1 | 1.90 | 1.36 | 63.3 | 1.90 | 1.36 | 63.4 | 1.90 | 1.37 |
| 9.60 | 62.2 | 1.90 | 1.34 | 62.3 | 1.90 | 1.34 | 62.4 | 1.90 | 1.35 | 62.6 | 1.90 | 1.35 | 62.7 | 1.90 | 1.35 | 62.9 | 1.90 | 1.35 | 63.0 | 1.90 | 1.36 | 63.1 | 1.90 | 1.36 | 63.3 | 1.90 | 1.36 | 63.4 | 1.90 | 1.37 |
| 9.70 | 62.2 | 1.90 | 1.34 | 62.3 | 1.90 | 1.34 | 62.5 | 1.90 | 1.34 | 62.6 | 1.90 | 1.35 | 62.7 | 1.90 | 1.35 | 62.9 | 1.90 | 1.35 | 63.0 | 1.90 | 1.36 | 63.2 | 1.90 | 1.36 | 63.3 | 1.90 | 1.36 | 63.5 | 1.90 | 1.36 |
| 9.80 | 62.2 | 1.91 | 1.34 | 62.3 | 1.91 | 1.34 | 62.5 | 1.91 | 1.34 | 62.6 | 1.91 | 1.35 | 62.8 | 1.91 | 1.35 | 62.9 | 1.91 | 1.35 | 63.1 | 1.91 | 1.35 | 63.2 | 1.91 | 1.36 | 63.3 | 1.91 | 1.36 | 63.5 | 1.91 | 1.36 |
| 9.90 | 62.2 | 1.91 | 1.34 | 62.4 | 1.91 | 1.34 | 62.5 | 1.91 | 1.34 | 62.6 | 1.91 | 1.34 | 62.8 | 1.91 | 1.35 | 62.9 | 1.91 | 1.35 | 63.1 | 1.91 | 1.35 | 63.2 | 1.91 | 1.36 | 63.4 | 1.91 | 1.36 | 63.5 | 1.91 | 1.36 |
| 10.00 | 62.2 | 1.91 | 1.33 | 62.4 | 1.91 | 1.34 | 62.5 | 1.91 | 1.34 | 62.7 | 1.91 | 1.34 | 62.8 | 1.91 | 1.35 | 63.0 | 1.91 | 1.35 | 63.1 | 1.91 | 1.35 | 63.2 | 1.91 | 1.35 | 63.4 | 1.91 | 1.36 | 63.5 | 1.91 | 1.36 |
| 10.10 | 62.3 | 1.91 | 1.33 | 62.4 | 1.91 | 1.33 | 62.5 | 1.91 | 1.34 | 62.7 | 1.91 | 1.34 | 62.8 | 1.91 | 1.34 | 63.0 | 1.91 | 1.35 | 63.1 | 1.91 | 1.35 | 63.3 | 1.91 | 1.35 | 63.4 | 1.91 | 1.35 | 63.5 | 1.91 | 1.36 |
| 10.20 | 62.3 | 1.92 | 1.33 | 62.4 | 1.92 | 1.33 | 62.6 | 1.92 | 1.34 | 62.7 | 1.92 | 1.34 | 62.8 | 1.92 | 1.34 | 63.0 | 1.92 | 1.34 | 63.1 | 1.92 | 1.35 | 63.3 | 1.92 | 1.35 | 63.4 | 1.92 | 1.35 | 63.6 | 1.92 | 1.36 |
| 10.30 | 62.3 | 1.92 | 1.33 | 62.4 | 1.92 | 1.33 | 62.6 | 1.92 | 1.33 | 62.7 | 1.92 | 1.34 | 62.9 | 1.92 | 1.34 | 63.0 | 1.92 | 1.34 | 63.2 | 1.92 | 1.35 | 63.3 | 1.92 | 1.35 | 63.4 | 1.92 | 1.35 | 63.6 | 1.92 | 1.35 |
| 10.40 | 62.3 | 1.92 | 1.33 | 62.5 | 1.92 | 1.33 | 62.6 | 1.92 | 1.33 | 62.7 | 1.92 | 1.34 | 62.9 | 1.92 | 1.34 | 63.0 | 1.92 | 1.34 | 63.2 | 1.92 | 1.34 | 63.3 | 1.92 | 1.35 | 63.5 | 1.92 | 1.35 | 63.6 | 1.92 | 1.35 |
| 10.50 | 62.3 | 1.92 | 1.32 | 62.5 | 1.92 | 1.33 | 62.6 | 1.92 | 1.33 | 62.8 | 1.92 | 1.33 | 62.9 | 1.92 | 1.34 | 63.1 | 1.92 | 1.34 | 63.2 | 1.92 | 1.34 | 63.3 | 1.92 | 1.35 | 63.5 | 1.92 | 1.35 | 63.6 | 1.92 | 1.35 |
| 10.60 | 62.4 | 1.92 | 1.32 | 62.5 | 1.92 | 1.33 | 62.6 | 1.92 | 1.33 | 62.8 | 1.92 | 1.33 | 62.9 | 1.92 | 1.33 | 63.1 | 1.92 | 1.34 | 63.2 | 1.92 | 1.34 | 63.4 | 1.92 | 1.34 | 63.5 | 1.92 | 1.35 | 63.7 | 1.92 | 1.35 |
| 10.70 | 62.4 | 1.93 | 1.32 | 62.5 | 1.93 | 1.32 | 62.7 | 1.93 | 1.33 | 62.8 | 1.93 | 1.33 | 63.0 | 1.93 | 1.33 | 63.1 | 1.93 | 1.34 | 63.2 | 1.93 | 1.34 | 63.4 | 1.93 | 1.34 | 63.5 | 1.93 | 1.34 | 63.7 | 1.93 | 1.35 |
| 10.80 | 62.4 | 1.93 | 1.32 | 61.9 | 1.93 | 1.31 | 62.7 | 1.93 | 1.33 | 62.8 | 1.93 | 1.33 | 63.0 | 1.93 | 1.33 | 63.1 | 1.93 | 1.33 | 62.7 | 1.93 | 1.33 | 63.4 | 1.93 | 1.34 | 63.6 | 1.93 | 1.34 | 63.7 | 1.93 | 1.35 |
| 10.90 | 62.4 | 1.93 | 1.32 | 62.6 | 1.93 | 1.32 | 62.7 | 1.93 | 1.32 | 62.9 | 1.93 | 1.33 | 63.0 | 1.93 | 1.33 | 63.1 | 1.93 | 1.33 | 63.3 | 1.93 | 1.34 | 63.4 | 1.93 | 1.34 | 63.6 | 1.93 | 1.34 | 63.7 | 1.93 | 1.34 |
| 11.00 | 62.4 | 1.93 | 1.32 | 62.6 | 1.93 | 1.32 | 62.7 | 1.93 | 1.32 | 62.9 | 1.93 | 1.32 | 63.0 | 1.93 | 1.33 | 63.2 | 1.93 | 1.33 | 63.3 | 1.93 | 1.33 | 63.5 | 1.93 | 1.34 | 63.6 | 1.93 | 1.34 | 63.7 | 1.93 | 1.34 |
| 11.10 | 62.5 | 1.93 | 1.31 | 62.6 | 1.93 | 1.32 | 62.8 | 1.93 | 1.32 | 62.9 | 1.93 | 1.32 | 63.0 | 1.93 | 1.33 | 63.2 | 1.93 | 1.33 | 63.3 | 1.93 | 1.33 | 63.5 | 1.93 | 1.33 | 63.6 | 1.93 | 1.34 | 63.8 | 1.93 | 1.34 |
| 11.20 | 62.5 | 1.94 | 1.31 | 62.6 | 1.94 | 1.32 | 62.8 | 1.94 | 1.32 | 62.9 | 1.94 | 1.32 | 63.1 | 1.94 | 1.32 | 63.2 | 1.94 | 1.33 | 63.4 | 1.94 | 1.33 | 63.5 | 1.94 | 1.33 | 63.6 | 1.94 | 1.34 | 63.8 | 1.94 | 1.34 |
| 11.30 | 62.5 | 1.94 | 1.31 | 62.7 | 1.94 | 1.31 | 62.8 | 1.94 | 1.32 | 62.9 | 1.94 | 1.32 | 63.1 | 1.94 | 1.32 | 63.2 | 1.94 | 1.33 | 63.4 | 1.94 | 1.33 | 63.5 | 1.94 | 1.33 | 63.7 | 1.94 | 1.33 | 63.8 | 1.94 | 1.34 |
| 11.40 | 62.5 | 1.94 | 1.31 | 62.7 | 1.94 | 1.31 | 62.8 | 1.94 | 1.32 | 63.0 | 1.94 | 1.32 | 63.1 | 1.94 | 1.32 | 63.3 | 1.94 | 1.32 | 63.4 | 1.94 | 1.33 | 63.5 | 1.94 | 1.33 | 63.7 | 1.94 | 1.33 | 63.8 | 1.94 | 1.34 |
| 11.50 | 62.5 | 1.94 | 1.31 | 62.7 | 1.94 | 1.31 | 62.8 | 1.94 | 1.31 | 63.0 | 1.94 | 1.32 | 63.1 | 1.94 | 1.32 | 63.3 | 1.94 | 1.32 | 63.4 | 1.94 | 1.32 | 63.6 | 1.94 | 1.33 | 63.7 | 1.94 | 1.33 | 63.9 | 1.94 | 1.33 |
| 11.60 | 62.6 | 1.95 | 1.31 | 62.7 | 1.95 | 1.31 | 62.9 | 1.95 | 1.31 | 63.0 | 1.95 | 1.31 | 63.2 | 1.95 | 1.32 | 63.3 | 1.95 | 1.32 | 63.4 | 1.95 | 1.32 | 63.6 | 1.95 | 1.33 | 63.7 | 1.95 | 1.33 | 63.9 | 1.95 | 1.33 |
| 11.70 | 62.6 | 1.95 | 1.30 | 62.7 | 1.95 | 1.31 | 62.9 | 1.95 | 1.31 | 63.0 | 1.95 | 1.31 | 63.2 | 1.95 | 1.32 | 63.3 | 1.95 | 1.32 | 63.5 | 1.95 | 1.32 | 63.6 | 1.95 | 1.32 | 63.8 | 1.95 | 1.33 | 63.9 | 1.95 | 1.33 |
| 11.80 | 62.6 | 1.95 | 1.30 | 62.8 | 1.95 | 1.31 | 62.9 | 1.95 | 1.31 | 63.1 | 1.95 | 1.31 | 63.2 | 1.95 | 1.31 | 63.3 | 1.95 | 1.32 | 63.5 | 1.95 | 1.32 | 63.6 | 1.95 | 1.32 | 63.8 | 1.95 | 1.33 | 63.9 | 1.95 | 1.33 |
| 11.90 | 62.6 | 1.95 | 1.30 | 62.8 | 1.95 | 1.30 | 62.9 | 1.95 | 1.31 | 63.1 | 1.95 | 1.31 | 63.2 | 1.95 | 1.31 | 63.4 | 1.95 | 1.32 | 63.5 | 1.95 | 1.32 | 63.7 | 1.95 | 1.32 | 63.8 | 1.95 | 1.32 | 64.0 | 1.95 | 1.33 |
| 12.00 | 62.7 | 1.95 | 1.30 | 62.8 | 1.95 | 1.30 | 63.0 | 1.95 | 1.30 | 63.1 | 1.95 | 1.31 | 63.2 | 1.95 | 1.31 | 63.4 | 1.95 | 1.31 | 63.5 | 1.95 | 1.32 | 63.7 | 1.95 | 1.32 | 63.8 | 1.95 | 1.32 | 64.0 | 1.95 | 1.32 |
| 12.10 | 62.7 | 1.96 | 1.30 | 62.8 | 1.96 | 1.30 | 63.0 | 1.96 | 1.30 | 63.1 | 1.96 | 1.31 | 63.3 | 1.96 | 1.31 | 63.4 | 1.96 | 1.31 | 63.6 | 1.96 | 1.31 | 63.7 | 1.96 | 1.32 | 63.9 | 1.96 | 1.32 | 64.0 | 1.96 | 1.32 |
| 12.30 | 62.7 | 1.96 | 1.29 | 62.9 | 1.96 | 1.30 | 63.0 | 1.96 | 1.30 | 63.2 | 1.96 | 1.30 | 63.3 | 1.96 | 1.30 | 63.5 | 1.96 | 1.31 | 63.6 | 1.96 | 1.31 | 63.8 | 1.96 | 1.31 | 63.9 | 1.96 | 1.32 | 64.0 | 1.96 | 1.32 |
| 12.30 | 62.7 | 1.96 | 1.29 | 62.9 | 1.96 | 1.30 | 63.0 | 1.96 | 1.30 | 63.2 | 1.96 | 1.30 | 63.3 | 1.96 | 1.30 | 63.5 | 1.96 | 1.31 | 63.6 | 1.96 | 1.31 | 63.8 | 1.96 | 1.31 | 63.9 | 1.96 | 1.32 | 64.0 | 1.96 | 1.32 |
| 12.40 | 62.7 | 1.96 | 1.29 | 62.9 | 1.96 | 1.29 | 63.0 | 1.96 | 1.30 | 63.2 | 1.96 | 1.30 | 63.3 | 1.96 | 1.30 | 63.5 | 1.96 | 1.31 | 63.6 | 1.96 | 1.31 | 63.8 | 1.96 | 1.31 | 63.9 | 1.96 | 1.31 | 64.1 | 1.96 | 1.32 |
| 12.50 | 62.8 | 1.97 | 1.29 | 62.9 | 1.97 | 1.29 | 63.1 | 1.97 | 1.30 | 63.2 | 1.97 | 1.30 | 63.4 | 1.97 | 1.30 | 63.5 | 1.97 | 1.30 | 63.7 | 1.97 | 1.31 | 63.8 | 1.97 | 1.31 | 63.9 | 1.97 | 1.31 | 64.1 | 1.97 | 1.32 |
| 12.60 | 62.8 | 1.97 | 1.29 | 62.9 | 1.97 | 1.29 | 63.1 | 1.97 | 1.29 | 63.2 | 1.97 | 1.30 | 63.4 | 1.97 | 1.30 | 63.5 | 1.97 | 1.30 | 63.7 | 1.97 | 1.31 | 63.8 | 1.97 | 1.31 | 64.0 | 1.97 | 1.31 | 64.1 | 1.97 | 1.31 |
| 12.70 | 62.8 | 1.97 | 1.29 | 63.0 | 1.97 | 1.29 | 63.1 | 1.97 | 1.29 | 63.3 | 1.97 | 1.29 | 63.4 | 1.97 | 1.30 | 63.5 | 1.97 | 1.30 | 63.7 | 1.97 | 1.30 | 63.8 | 1.97 | 1.31 | 64.0 | 1.97 | 1.31 | 64.1 | 1.97 | 1.31 |
| 12.80 | 62.8 | 1.97 | 1.28 | 63.0 | 1.97 | 1.29 | 63.1 | 1.97 | 1.29 | 63.3 | 1.97 | 1.29 | 63.4 | 1.97 | 1.30 | 63.6 | 1.97 | 1.30 | 63.7 | 1.97 | 1.30 | 63.9 | 1.97 | 1.30 | 64.0 | 1.97 | 1.31 | 64.2 | 1.97 | 1.31 |
| 12.90 | 62.9 | 1.97 | 1.28 | 63.0 | 1.97 | 1.29 | 63.1 | 1.97 | 1.29 | 63.3 | 1.97 | 1.29 | 63.4 | 1.97 | 1.29 | 63.6 | 1.97 | 1.30 | 63.7 | 1.97 | 1.30 | 63.9 | 1.97 | 1.30 | 64.0 | 1.97 | 1.31 | 64.2 | 1.97 | 1.31 |
| 13.00 | 62.9 | 1.98 | 1.28 | 63.0 | 1.98 | 1.28 | 63.2 | 1.98 | 1.29 | 63.3 | 1.98 | 1.29 | 63.5 | 1.98 | 1.29 | 63.6 | 1.98 | 1.30 | 63.8 | 1.98 | 1.30 | 63.9 | 1.98 | 1.30 | 64.1 | 1.98 | 1.30 | 64.2 | 1.98 | 1.31 |
| 13.10 | 62.9 | 1.98 | 1.28 | 63.0 | 1.98 | 1.28 | 63.2 | 1.98 | 1.28 | 63.3 | 1.98 | 1.29 | 63.5 | 1.98 | 1.29 | 63.6 | 1.98 | 1.29 | 63.8 | 1.98 | 1.30 | 63.9 | 1.98 | 1.30 | 64.1 | 1.98 | 1.30 | 64.2 | 1.98 | 1.31 |
| 13.20 | 62.9 | 1.98 | 1.28 | 63.1 | 1.98 | 1.28 | 63.2 | 1.98 | 1.28 | 63.4 | 1.98 | 1.29 | 63.5 | 1.98 | 1.29 | 63.7 | 1.98 | 1.29 | 63.8 | 1.98 | 1.29 | 64.0 | 1.98 | 1.30 | 64.1 | 1.98 | 1.30 | 64.3 | 1.98 | 1.30 |
| 13.30 | 62.9 | 1.98 | 1.27 | 63.1 | 1.98 | 1.28 | 63.2 | 1.98 | 1.28 | 63.4 | 1.98 | 1.28 | 63.5 | 1.98 | 1.29 | 63.7 | 1.98 | 1.29 | 63.8 | 1.98 | 1.29 | 64.0 | 1.98 | 1.30 | 64.1 | 1.98 | 1.30 | 64.3 | 1.98 | 1.30 |
| 13.40 | 63.0 | 1.99 | 1.27 | 63.1 | 1.99 | 1.28 | 63.3 | 1.99 | 1.28 | 63.4 | 1.99 | 1.28 | 63.6 | 1.99 | 1.29 | 63.7 | 1.99 | 1.29 | 63.9 | 1.99 | 1.29 | 64.0 | 1.99 | 1.29 | 64.2 | 1.99 | 1.30 | 64.3 | 1.99 | 1.30 |
| 13.50 | 63.0 | 1.99 | 1.27 | 63.1 | 1.99 | 1.27 | 63.3 | 1.99 | 1.28 | 63.4 | 1.99 | 1.28 | 63.6 | 1.99 | 1.28 | 63.7 | 1.99 | 1.29 | 63.9 | 1.99 | 1.29 | 64.0 | 1.99 | 1.29 | 64.2 | 1.99 | 1.30 | 64.3 | 1.99 | 1.30 |
| 13.60 | 63.0 | 1.99 | 1.27 | 63.2 | 1.99 | 1.27 | 63.3 | 1.99 | 1.28 | 63.5 | 1.99 | 1.28 | 63.6 | 1.99 | 1.28 | 63.8 | 1.99 | 1.28 | 63.9 | 1.99 | 1.29 | 64.1 | 1.99 | 1.29 | 64.2 | 1.99 | 1.29 | 64.4 | 1.99 | 1.30 |
| 13.70 | 63.0 | 1.99 | 1.27 | 63.2 | 1.99 | 1.27 | 63.3 | 1.99 | 1.27 | 63.5 | 1.99 | 1.28 | 63.6 | 1.99 | 1.28 | 63.8 | 1.99 | 1.28 | 63.9 | 1.99 | 1.29 | 64.1 | 1.99 | 1.29 | 64.2 | 1.99 | 1.29 | 64.4 | 1.99 | 1.29 |
| 13.80 | 63.1 | 2.00 | 1.27 | 63.2 | 2.00 | 1.27 | 63.4 | 2.00 | 1.27 | 63.5 | 2.00 | 1.27 | 63.7 | 2.00 | 1.28 | 63.8 | 2.00 | 1.28 | 64.0 | 2.00 | 1.28 | 64.1 | 2.00 | 1.29 | 64.3 | 2.00 | 1.29 | 64.4 | 2.00 | 1.29 |
| 13.90 | 63.1 | 2.00 | 1.26 | 63.2 | 2.00 | 1.27 | 63.4 | 2.00 | 1.27 | 63.5 | 2.00 | 1.27 | 63.7 | 2.00 | 1.28 | 63.8 | 2.00 | 1.28 | 64.0 | 2.00 | 1.28 | 64.1 | 2.00 | 1.28 | 64.3 | 2.00 | 1.29 | 64.4 | 2.00 | 1.29 |
| 14.00 | 63.1 | 2.00 | 1.26 | 63.3 | 2.00 | 1.27 | 63.4 | 2.00 | 1.27 | 63.6 | 2.00 | 1.27 | 63.7 | 2.00 | 1.27 | 63.9 | 2.00 | 1.28 | 64.0 | 2.00 | 1.28 | 64.2 | 2.00 | 1.28 | 64.3 | 2.00 | 1.29 | 64.5 | 2.00 | 1.29 |
| 14.10 | 63.1 | 2.00 | 1.26 | 63.3 | 2.00 | 1.26 | 63.4 | 2.00 | 1.27 | 63.6 | 2.00 | 1.27 | 63.7 | 2.00 | 1.27 | 63.9 | 2.00 | 1.28 | 64.0 | 2.00 | 1.28 | 64.2 | 2.00 | 1.28 | 64.3 | 2.00 | 1.28 | 64.5 | 2.00 | 1.29 |
| 14.20 | 63.1 | 2.00 | 1.26 | 63.3 | 2.00 | 1.26 | 63.4 | 2.00 | 1.26 | 63.6 | 2.00 | 1.27 | 63.7 | 2.00 | 1.27 | 63.9 | 2.00 | 1.27 | 64.0 | 2.00 | 1.28 | 64.2 | 2.00 | 1.28 | 64.3 | 2.00 | 1.28 | 64.5 | 2.00 | 1.29 |
| 14.30 | 63.2 | 2.01 | 1.26 | 63.3 | 2.01 | 1.26 | 63.5 | 2.01 | 1.26 | 63.6 | 2.01 | 1.27 | 63.8 | 2.01 | 1.27 | 63.9 | 2.01 | 1.27 | 64.1 | 2.01 | 1.27 | 64.2 | 2.01 | 1.28 | 64.4 | 2.01 | 1.28 | 64.5 | 2.01 | 1.28 |
| 14.40 | 63.2 | 2.01 | 1.25 | 63.3 | 2.01 | 1.26 | 63.5 | 2.01 | 1.26 | 63.6 | 2.01 | 1.26 | 63.8 | 2.01 | 1.27 | 63.9 | 2.01 | 1.27 | 64.1 | 2.01 | 1.27 | 64.2 | 2.01 | 1.28 | 64.4 | 2.01 | 1.28 | 64.5 | 2.01 | 1.28 |
| 14.50 | 63.2 | 2.01 | 1.25 | 63.4 | 2.01 | 1.26 | 63.5 | 2.01 | 1.26 | 63.7 | 2.01 | 1.26 | 63.8 | 2.01 | 1.26 | 64.0 | 2.01 | 1.27 | 64.1 | 2.01 | 1.27 | 64.3 | 2.01 | 1.27 | 64.4 | 2.01 | 1.28 | 64.6 | 2.01 | 1.28 |
| 14.60 | 63.2 | 2.01 | 1.25 | 63.4 | 2.01 | 1.25 | 63.5 | 2.01 | 1.26 | 63.7 | 2.01 | 1.26 | 63.8 | 2.01 | 1.26 | 64.0 | 2.01 | 1.27 | 64.1 | 2.01 | 1.27 | 64.3 | 2.01 | 1.27 | 64.4 | 2.01 | 1.27 | 64.6 | 2.01 | 1.28 |
| 14.70 | 63.3 | 2.02 | 1.25 | 63.4 | 2.02 | 1.25 | 63.6 | 2.02 | 1.25 | 63.7 | 2.02 | 1.26 | 63.9 | 2.02 | 1.26 | 64.0 | 2.02 | 1.26 | 64.2 | 2.02 | 1.27 | 64.3 | 2.02 | 1.27 | 64.5 | 2.02 | 1.27 | 64.6 | 2.02 | 1.28 |
| 14.80 | 63.3 | 2.02 | 1.25 | 63.4 | 2.02 | 1.25 | 63.6 | 2.02 | 1.25 | 63.7 | 2.02 | 1.26 | 63.9 | 2.02 | 1.26 | 64.0 | 2.02 | 1.26 | 64.2 | 2.02 | 1.27 | 64.3 | 2.02 | 1.27 | 64.5 | 2.02 | 1.27 | 64.6 | 2.02 | 1.27 |
| 14.90 | 63.3 | 2.02 | 1.24 | 63.5 | 2.02 | 1.25 | 63.6 | 2.02 | 1.25 | 63.8 | 2.02 | 1.25 | 63.9 | 2.02 | 1.26 | 64.1 | 2.02 | 1.26 | 64.2 | 2.02 | 1.26 | 64.4 | 2.02 | 1.27 | 64.5 | 2.02 | 1.27 | 64.7 | 2.02 | 1.27 |
| 15.00 | 63.3 | 2.02 | 1.24 | 63.5 | 2.02 | 1.25 | 63.6 | 2.02 | 1.25 | 63.8 | 2.02 | 1.25 | 63.9 | 2.02 | 1.26 | 64.1 | 2.02 | 1.26 | 64.2 | 2.02 | 1.26 | 64.4 | 2.02 | 1.26 | 64.5 | 2.02 | 1.27 | 64.7 | 2.02 | 1.27 |
| 15.10 | 63.4 | 2.03 | 1.24 | 63.5 | 2.03 | 1.24 | 63.7 | 2.03 | 1.25 | 63.8 | 2.03 | 1.25 | 64.0 | 2.03 | 1.25 | 64.1 | 2.03 | 1.26 | 64.3 | 2.03 | 1.26 | 64.4 | 2.03 | 1.26 | 64.6 | 2.03 | 1.27 | 64.7 | 2.03 | 1.27 |
| 15.20 | 63.4 | 2.03 | 1.24 | 63.5 | 2.03 | 1.24 | 63.7 | 2.03 | 1.25 | 63.8 | 2.03 | 1.25 | 64.0 | 2.03 | 1.25 | 64.1 | 2.03 | 1.25 | 64.3 | 2.03 | 1.26 | 64.4 | 2.03 | 1.26 | 64.6 | 2.03 | 1.26 | 64.7 | 2.03 | 1.27 |
| 15.30 | 63.4 | 2.03 | 1.24 | 63.6 | 2.03 | 1.24 | 63.7 | 2.03 | 1.24 | 63.9 | 2.03 | 1.25 | 64.0 | 2.03 | 1.25 | 64.2 | 2.03 | 1.25 | 64.3 | 2.03 | 1.26 | 64.5 | 2.03 | 1.26 | 64.6 | 2.03 | 1.26 | 64.8 | 2.03 | 1.26 |
| 15.40 | 63.4 | 2.03 | 1.24 | 63.6 | 2.03 | 1.24 | 63.7 | 2.03 | 1.24 | 63.9 | 2.03 | 1.24 | 64.0 | 2.03 | 1.25 | 64.2 | 2.03 | 1.25 | 64.3 | 2.03 | 1.25 | 64.5 | 2.03 | 1.26 | 64.6 | 2.03 | 1.26 | 64.8 | 2.03 | 1.26 |
| 15.50 | 63.4 | 2.04 | 1.23 | 63.6 | 2.04 | 1.24 | 63.8 | 2.04 | 1.24 | 63.9 | 2.04 | 1.24 | 64.1 | 2.04 | 1.25 | 64.2 | 2.04 | 1.25 | 64.4 | 2.04 | 1.25 | 64.5 | 2.04 | 1.25 | 64.7 | 2.04 | 1.26 | 64.8 | 2.04 | 1.26 |
| 15.60 | 63.5 | 2.04 | 1.23 | 63.6 | 2.04 | 1.23 | 63.8 | 2.04 | 1.24 | 63.9 | 2.04 | 1.24 | 64.1 | 2.04 | 1.24 | 64.2 | 2.04 | 1.25 | 64.4 | 2.04 | 1.25 | 64.5 | 2.04 | 1.25 | 64.7 | 2.04 | 1.26 | 64.8 | 2.04 | 1.26 |
| 15.70 | 63.5 | 2.04 | 1.23 | 63.6 | 2.04 | 1.23 | 63.8 | 2.04 | 1.24 | 64.0 | 2.04 | 1.24 | 64.1 | 2.04 | 1.24 | 64.3 | 2.04 | 1.24 | 64.4 | 2.04 | 1.25 | 64.6 | 2.04 | 1.25 | 64.7 | 2.04 | 1.25 | 64.9 | 2.04 | 1.26 |
| 15.80 | 63.5 | 2.04 | 1.23 | 63.7 | 2.04 | 1.23 | 63.8 | 2.04 | 1.23 | 64.0 | 2.04 | 1.24 | 64.1 | 2.04 | 1.24 | 64.3 | 2.04 | 1.24 | 64.4 | 2.04 | 1.25 | 64.6 | 2.04 | 1.25 | 64.7 | 2.04 | 1.25 | 64.9 | 2.04 | 1.26 |
| 15.90 | 63.5 | 2.05 | 1.23 | 63.7 | 2.05 | 1.23 | 63.8 | 2.05 | 1.23 | 64.0 | 2.05 | 1.23 | 64.2 | 2.05 | 1.24 | 64.3 | 2.05 | 1.24 | 64.5 | 2.05 | 1.24 | 64.6 | 2.05 | 1.25 | 64.8 | 2.05 | 1.25 | 64.9 | 2.05 | 1.25 |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 2.0; Water (ml) = (% Absorption x 2.0 / 100) + (2.0 - sample weight)

## 2-gram Mixograph: Absorption, Flour and Water Amount Table
## (14.0 - 14.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 14.00 | | | 14.10 | | | 14.20 | | | 14.30 | | | 14.40 | | | 14.50 | | | 14.60 | | | 14.70 | | | 14.80 | | | 14.90 | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml |
| 9.00 | 63.4 | 1.89 | 1.38 | 63.6 | 1.89 | 1.38 | 63.7 | 1.89 | 1.38 | 63.9 | 1.89 | 1.39 | 64.0 | 1.89 | 1.39 | 64.2 | 1.89 | 1.39 | 64.3 | 1.89 | 1.40 | 64.4 | 1.89 | 1.40 | 64.6 | 1.89 | 1.40 | 64.7 | 1.89 | 1.40 |
| 9.10 | 63.5 | 1.89 | 1.38 | 63.6 | 1.89 | 1.38 | 63.8 | 1.89 | 1.38 | 63.9 | 1.89 | 1.39 | 64.0 | 1.89 | 1.39 | 64.2 | 1.89 | 1.39 | 64.3 | 1.89 | 1.39 | 64.5 | 1.89 | 1.40 | 64.6 | 1.89 | 1.40 | 64.7 | 1.89 | 1.40 |
| 9.20 | 63.5 | 1.89 | 1.38 | 63.6 | 1.89 | 1.38 | 63.8 | 1.89 | 1.38 | 63.9 | 1.89 | 1.38 | 64.1 | 1.89 | 1.39 | 64.2 | 1.89 | 1.39 | 64.3 | 1.89 | 1.39 | 64.5 | 1.89 | 1.40 | 64.6 | 1.89 | 1.40 | 64.8 | 1.89 | 1.40 |
| 9.30 | 63.5 | 1.90 | 1.37 | 63.7 | 1.90 | 1.38 | 63.8 | 1.90 | 1.38 | 63.9 | 1.90 | 1.38 | 64.1 | 1.90 | 1.39 | 64.2 | 1.90 | 1.39 | 64.4 | 1.90 | 1.39 | 64.5 | 1.90 | 1.39 | 64.6 | 1.90 | 1.40 | 64.8 | 1.90 | 1.40 |
| 9.40 | 63.5 | 1.90 | 1.37 | 63.7 | 1.90 | 1.38 | 63.8 | 1.90 | 1.38 | 64.0 | 1.90 | 1.38 | 64.1 | 1.90 | 1.38 | 64.2 | 1.90 | 1.39 | 64.4 | 1.90 | 1.39 | 64.5 | 1.90 | 1.39 | 64.7 | 1.90 | 1.40 | 64.8 | 1.90 | 1.40 |
| 9.50 | 63.6 | 1.90 | 1.37 | 63.7 | 1.90 | 1.37 | 63.8 | 1.90 | 1.38 | 64.0 | 1.90 | 1.38 | 64.1 | 1.90 | 1.38 | 64.3 | 1.90 | 1.38 | 64.4 | 1.90 | 1.39 | 64.6 | 1.90 | 1.39 | 64.7 | 1.90 | 1.39 | 64.8 | 1.90 | 1.40 |
| 9.60 | 63.6 | 1.90 | 1.37 | 63.7 | 1.90 | 1.37 | 63.9 | 1.90 | 1.37 | 64.0 | 1.90 | 1.38 | 64.1 | 1.90 | 1.38 | 64.3 | 1.90 | 1.38 | 64.4 | 1.90 | 1.39 | 64.6 | 1.90 | 1.39 | 64.7 | 1.90 | 1.39 | 64.9 | 1.90 | 1.39 |
| 9.70 | 63.6 | 1.90 | 1.37 | 63.7 | 1.90 | 1.37 | 63.9 | 1.90 | 1.37 | 64.0 | 1.90 | 1.38 | 64.2 | 1.90 | 1.38 | 64.3 | 1.90 | 1.38 | 64.5 | 1.90 | 1.38 | 64.6 | 1.90 | 1.39 | 64.7 | 1.90 | 1.39 | 64.9 | 1.90 | 1.39 |
| 9.80 | 63.6 | 1.91 | 1.37 | 63.8 | 1.91 | 1.37 | 63.9 | 1.91 | 1.37 | 64.1 | 1.91 | 1.37 | 64.2 | 1.91 | 1.38 | 64.3 | 1.91 | 1.38 | 64.5 | 1.91 | 1.38 | 64.6 | 1.91 | 1.39 | 64.8 | 1.91 | 1.39 | 64.9 | 1.91 | 1.39 |
| 9.90 | 63.6 | 1.91 | 1.36 | 63.8 | 1.91 | 1.37 | 63.9 | 1.91 | 1.37 | 64.1 | 1.91 | 1.37 | 64.2 | 1.91 | 1.38 | 64.4 | 1.91 | 1.38 | 64.5 | 1.91 | 1.38 | 64.6 | 1.91 | 1.38 | 64.8 | 1.91 | 1.39 | 64.9 | 1.91 | 1.39 |
| 10.00 | 63.7 | 1.91 | 1.36 | 63.8 | 1.91 | 1.37 | 64.0 | 1.91 | 1.37 | 64.1 | 1.91 | 1.37 | 64.2 | 1.91 | 1.37 | 64.4 | 1.91 | 1.38 | 64.5 | 1.91 | 1.38 | 64.7 | 1.91 | 1.38 | 64.8 | 1.91 | 1.39 | 65.0 | 1.91 | 1.39 |
| 10.10 | 63.7 | 1.91 | 1.36 | 63.8 | 1.91 | 1.36 | 64.0 | 1.91 | 1.37 | 64.1 | 1.91 | 1.37 | 64.3 | 1.91 | 1.37 | 64.4 | 1.91 | 1.37 | 64.5 | 1.91 | 1.38 | 64.7 | 1.91 | 1.38 | 64.8 | 1.91 | 1.38 | 65.0 | 1.91 | 1.39 |
| 10.20 | 63.7 | 1.92 | 1.36 | 63.9 | 1.92 | 1.36 | 64.0 | 1.92 | 1.36 | 64.1 | 1.92 | 1.37 | 64.3 | 1.92 | 1.37 | 64.4 | 1.92 | 1.37 | 64.6 | 1.92 | 1.38 | 64.7 | 1.92 | 1.38 | 64.9 | 1.92 | 1.38 | 65.0 | 1.92 | 1.38 |
| 10.30 | 63.7 | 1.92 | 1.36 | 63.9 | 1.92 | 1.36 | 64.0 | 1.92 | 1.36 | 64.2 | 1.92 | 1.37 | 64.3 | 1.92 | 1.37 | 64.5 | 1.92 | 1.37 | 64.6 | 1.92 | 1.37 | 64.7 | 1.92 | 1.38 | 64.9 | 1.92 | 1.38 | 65.0 | 1.92 | 1.38 |
| 10.40 | 63.8 | 1.92 | 1.36 | 63.9 | 1.92 | 1.36 | 64.0 | 1.92 | 1.36 | 64.2 | 1.92 | 1.36 | 64.3 | 1.92 | 1.37 | 64.5 | 1.92 | 1.37 | 64.6 | 1.92 | 1.37 | 64.8 | 1.92 | 1.38 | 64.9 | 1.92 | 1.38 | 65.1 | 1.92 | 1.38 |
| 10.50 | 63.8 | 1.92 | 1.35 | 63.9 | 1.92 | 1.36 | 64.1 | 1.92 | 1.36 | 64.2 | 1.92 | 1.36 | 64.4 | 1.92 | 1.37 | 64.5 | 1.92 | 1.37 | 64.6 | 1.92 | 1.37 | 64.8 | 1.92 | 1.37 | 64.9 | 1.92 | 1.38 | 65.1 | 1.92 | 1.38 |
| 10.60 | 63.8 | 1.92 | 1.35 | 63.9 | 1.92 | 1.35 | 64.1 | 1.92 | 1.36 | 64.2 | 1.92 | 1.36 | 64.4 | 1.92 | 1.36 | 64.5 | 1.92 | 1.37 | 64.7 | 1.92 | 1.37 | 64.8 | 1.92 | 1.37 | 65.0 | 1.92 | 1.38 | 65.1 | 1.92 | 1.38 |
| 10.70 | 63.8 | 1.93 | 1.35 | 64.0 | 1.93 | 1.35 | 64.1 | 1.93 | 1.36 | 64.3 | 1.93 | 1.36 | 64.4 | 1.93 | 1.36 | 64.5 | 1.93 | 1.36 | 64.7 | 1.93 | 1.37 | 64.8 | 1.93 | 1.37 | 65.0 | 1.93 | 1.37 | 65.1 | 1.93 | 1.38 |
| 10.80 | 63.8 | 1.93 | 1.35 | 63.4 | 1.93 | 1.34 | 64.1 | 1.93 | 1.35 | 64.3 | 1.93 | 1.36 | 64.4 | 1.93 | 1.36 | 64.6 | 1.93 | 1.36 | 64.1 | 1.93 | 1.35 | 64.9 | 1.93 | 1.37 | 65.0 | 1.93 | 1.37 | 65.1 | 1.93 | 1.37 |
| 10.90 | 63.9 | 1.93 | 1.35 | 64.0 | 1.93 | 1.35 | 64.2 | 1.93 | 1.35 | 64.3 | 1.93 | 1.36 | 64.4 | 1.93 | 1.36 | 64.6 | 1.93 | 1.36 | 64.7 | 1.93 | 1.36 | 64.9 | 1.93 | 1.37 | 65.0 | 1.93 | 1.37 | 65.2 | 1.93 | 1.37 |
| 11.00 | 63.9 | 1.93 | 1.35 | 64.0 | 1.93 | 1.35 | 64.2 | 1.93 | 1.35 | 64.3 | 1.93 | 1.35 | 64.5 | 1.93 | 1.36 | 64.6 | 1.93 | 1.36 | 64.8 | 1.93 | 1.36 | 64.9 | 1.93 | 1.37 | 65.1 | 1.93 | 1.37 | 65.2 | 1.93 | 1.37 |
| 11.10 | 63.9 | 1.93 | 1.34 | 64.1 | 1.93 | 1.35 | 64.2 | 1.93 | 1.35 | 64.4 | 1.93 | 1.35 | 64.5 | 1.93 | 1.36 | 64.6 | 1.93 | 1.36 | 64.8 | 1.93 | 1.36 | 64.9 | 1.93 | 1.36 | 65.1 | 1.93 | 1.37 | 65.2 | 1.93 | 1.37 |
| 11.20 | 63.9 | 1.94 | 1.34 | 64.1 | 1.94 | 1.34 | 64.2 | 1.94 | 1.35 | 64.4 | 1.94 | 1.35 | 64.5 | 1.94 | 1.35 | 64.7 | 1.94 | 1.36 | 64.8 | 1.94 | 1.36 | 65.0 | 1.94 | 1.36 | 65.1 | 1.94 | 1.37 | 65.2 | 1.94 | 1.37 |
| 11.30 | 64.0 | 1.94 | 1.34 | 64.1 | 1.94 | 1.34 | 64.3 | 1.94 | 1.35 | 64.4 | 1.94 | 1.35 | 64.5 | 1.94 | 1.35 | 64.7 | 1.94 | 1.35 | 64.8 | 1.94 | 1.36 | 65.0 | 1.94 | 1.36 | 65.1 | 1.94 | 1.36 | 65.3 | 1.94 | 1.37 |
| 11.40 | 64.0 | 1.94 | 1.34 | 64.1 | 1.94 | 1.34 | 64.3 | 1.94 | 1.34 | 64.4 | 1.94 | 1.35 | 64.6 | 1.94 | 1.35 | 64.7 | 1.94 | 1.35 | 64.9 | 1.94 | 1.36 | 65.0 | 1.94 | 1.36 | 65.1 | 1.94 | 1.36 | 65.3 | 1.94 | 1.36 |
| 11.50 | 64.0 | 1.94 | 1.34 | 64.2 | 1.94 | 1.34 | 64.3 | 1.94 | 1.34 | 64.4 | 1.94 | 1.35 | 64.6 | 1.94 | 1.35 | 64.7 | 1.94 | 1.35 | 64.9 | 1.94 | 1.35 | 65.0 | 1.94 | 1.36 | 65.2 | 1.94 | 1.36 | 65.3 | 1.94 | 1.36 |
| 11.60 | 64.0 | 1.95 | 1.33 | 64.2 | 1.95 | 1.34 | 64.3 | 1.95 | 1.34 | 64.5 | 1.95 | 1.34 | 64.6 | 1.95 | 1.35 | 64.8 | 1.95 | 1.35 | 64.9 | 1.95 | 1.35 | 65.1 | 1.95 | 1.36 | 65.2 | 1.95 | 1.36 | 65.3 | 1.95 | 1.36 |
| 11.70 | 64.1 | 1.95 | 1.33 | 64.2 | 1.95 | 1.34 | 64.3 | 1.95 | 1.34 | 64.5 | 1.95 | 1.34 | 64.6 | 1.95 | 1.34 | 64.8 | 1.95 | 1.35 | 64.9 | 1.95 | 1.35 | 65.1 | 1.95 | 1.35 | 65.2 | 1.95 | 1.36 | 65.4 | 1.95 | 1.36 |
| 11.80 | 64.1 | 1.95 | 1.33 | 64.2 | 1.95 | 1.33 | 64.4 | 1.95 | 1.34 | 64.5 | 1.95 | 1.34 | 64.7 | 1.95 | 1.34 | 64.8 | 1.95 | 1.35 | 65.0 | 1.95 | 1.35 | 65.1 | 1.95 | 1.35 | 65.2 | 1.95 | 1.35 | 65.4 | 1.95 | 1.36 |
| 11.90 | 64.1 | 1.95 | 1.33 | 64.2 | 1.95 | 1.33 | 64.4 | 1.95 | 1.34 | 64.5 | 1.95 | 1.34 | 64.7 | 1.95 | 1.34 | 64.8 | 1.95 | 1.34 | 65.0 | 1.95 | 1.35 | 65.1 | 1.95 | 1.35 | 65.3 | 1.95 | 1.35 | 65.4 | 1.95 | 1.36 |
| 12.00 | 64.1 | 1.95 | 1.33 | 64.3 | 1.95 | 1.33 | 64.4 | 1.95 | 1.33 | 64.6 | 1.95 | 1.34 | 64.7 | 1.95 | 1.34 | 64.9 | 1.95 | 1.34 | 65.0 | 1.95 | 1.35 | 65.1 | 1.95 | 1.35 | 65.3 | 1.95 | 1.35 | 65.4 | 1.95 | 1.35 |
| 12.10 | 64.1 | 1.96 | 1.33 | 64.3 | 1.96 | 1.33 | 64.4 | 1.96 | 1.33 | 64.6 | 1.96 | 1.33 | 64.7 | 1.96 | 1.34 | 64.9 | 1.96 | 1.34 | 65.0 | 1.96 | 1.34 | 65.2 | 1.96 | 1.35 | 65.3 | 1.96 | 1.35 | 65.5 | 1.96 | 1.35 |
| 12.30 | 64.2 | 1.96 | 1.32 | 64.3 | 1.96 | 1.33 | 64.5 | 1.96 | 1.33 | 64.6 | 1.96 | 1.33 | 64.8 | 1.96 | 1.33 | 64.9 | 1.96 | 1.34 | 65.1 | 1.96 | 1.34 | 65.2 | 1.96 | 1.34 | 65.4 | 1.96 | 1.35 | 65.5 | 1.96 | 1.35 |
| 12.30 | 64.2 | 1.96 | 1.32 | 64.3 | 1.96 | 1.33 | 64.5 | 1.96 | 1.33 | 64.6 | 1.96 | 1.33 | 64.8 | 1.96 | 1.33 | 64.9 | 1.96 | 1.34 | 65.1 | 1.96 | 1.34 | 65.2 | 1.96 | 1.34 | 65.4 | 1.96 | 1.35 | 65.5 | 1.96 | 1.35 |
| 12.40 | 64.2 | 1.96 | 1.32 | 64.4 | 1.96 | 1.32 | 64.5 | 1.96 | 1.33 | 64.7 | 1.96 | 1.33 | 64.8 | 1.96 | 1.33 | 65.0 | 1.96 | 1.34 | 65.1 | 1.96 | 1.34 | 65.2 | 1.96 | 1.34 | 65.4 | 1.96 | 1.34 | 65.5 | 1.96 | 1.35 |
| 12.50 | 64.2 | 1.97 | 1.32 | 64.4 | 1.97 | 1.32 | 64.5 | 1.97 | 1.32 | 64.7 | 1.97 | 1.33 | 64.8 | 1.97 | 1.33 | 65.0 | 1.97 | 1.33 | 65.1 | 1.97 | 1.34 | 65.3 | 1.97 | 1.34 | 65.4 | 1.97 | 1.34 | 65.6 | 1.97 | 1.35 |
| 12.60 | 64.3 | 1.97 | 1.32 | 64.4 | 1.97 | 1.32 | 64.6 | 1.97 | 1.32 | 64.7 | 1.97 | 1.33 | 64.9 | 1.97 | 1.33 | 65.0 | 1.97 | 1.33 | 65.1 | 1.97 | 1.34 | 65.3 | 1.97 | 1.34 | 65.4 | 1.97 | 1.34 | 65.6 | 1.97 | 1.34 |
| 12.70 | 64.3 | 1.97 | 1.32 | 64.4 | 1.97 | 1.32 | 64.6 | 1.97 | 1.32 | 64.7 | 1.97 | 1.32 | 64.9 | 1.97 | 1.33 | 65.0 | 1.97 | 1.33 | 65.2 | 1.97 | 1.33 | 65.3 | 1.97 | 1.34 | 65.5 | 1.97 | 1.34 | 65.6 | 1.97 | 1.34 |
| 12.80 | 64.3 | 1.97 | 1.31 | 64.5 | 1.97 | 1.32 | 64.6 | 1.97 | 1.32 | 64.8 | 1.97 | 1.32 | 64.9 | 1.97 | 1.33 | 65.1 | 1.97 | 1.33 | 65.2 | 1.97 | 1.33 | 65.3 | 1.97 | 1.33 | 65.5 | 1.97 | 1.34 | 65.6 | 1.97 | 1.34 |
| 12.90 | 64.3 | 1.97 | 1.31 | 64.5 | 1.97 | 1.31 | 64.6 | 1.97 | 1.32 | 64.8 | 1.97 | 1.32 | 64.9 | 1.97 | 1.32 | 65.1 | 1.97 | 1.33 | 65.2 | 1.97 | 1.33 | 65.4 | 1.97 | 1.33 | 65.5 | 1.97 | 1.34 | 65.7 | 1.97 | 1.34 |
| 13.00 | 64.4 | 1.98 | 1.31 | 64.5 | 1.98 | 1.31 | 64.7 | 1.98 | 1.32 | 64.8 | 1.98 | 1.32 | 65.0 | 1.98 | 1.32 | 65.1 | 1.98 | 1.32 | 65.2 | 1.98 | 1.33 | 65.4 | 1.98 | 1.33 | 65.5 | 1.98 | 1.33 | 65.7 | 1.98 | 1.34 |
| 13.10 | 64.4 | 1.98 | 1.31 | 64.5 | 1.98 | 1.31 | 64.7 | 1.98 | 1.31 | 64.8 | 1.98 | 1.32 | 65.0 | 1.98 | 1.32 | 65.1 | 1.98 | 1.32 | 65.3 | 1.98 | 1.33 | 65.4 | 1.98 | 1.33 | 65.6 | 1.98 | 1.33 | 65.7 | 1.98 | 1.34 |
| 13.20 | 64.4 | 1.98 | 1.31 | 64.6 | 1.98 | 1.31 | 64.7 | 1.98 | 1.31 | 64.9 | 1.98 | 1.32 | 65.0 | 1.98 | 1.32 | 65.1 | 1.98 | 1.32 | 65.3 | 1.98 | 1.32 | 65.4 | 1.98 | 1.33 | 65.6 | 1.98 | 1.33 | 65.7 | 1.98 | 1.33 |
| 13.30 | 64.4 | 1.98 | 1.30 | 64.6 | 1.98 | 1.31 | 64.7 | 1.98 | 1.31 | 64.9 | 1.98 | 1.31 | 65.0 | 1.98 | 1.32 | 65.2 | 1.98 | 1.32 | 65.3 | 1.98 | 1.32 | 65.5 | 1.98 | 1.33 | 65.6 | 1.98 | 1.33 | 65.8 | 1.98 | 1.33 |
| 13.40 | 64.5 | 1.99 | 1.30 | 64.6 | 1.99 | 1.31 | 64.8 | 1.99 | 1.31 | 64.9 | 1.99 | 1.31 | 65.1 | 1.99 | 1.31 | 65.2 | 1.99 | 1.32 | 65.3 | 1.99 | 1.32 | 65.5 | 1.99 | 1.32 | 65.6 | 1.99 | 1.33 | 65.8 | 1.99 | 1.33 |
| 13.50 | 64.5 | 1.99 | 1.30 | 64.6 | 1.99 | 1.30 | 64.8 | 1.99 | 1.31 | 64.9 | 1.99 | 1.31 | 65.1 | 1.99 | 1.31 | 65.2 | 1.99 | 1.32 | 65.4 | 1.99 | 1.32 | 65.5 | 1.99 | 1.32 | 65.7 | 1.99 | 1.32 | 65.8 | 1.99 | 1.33 |
| 13.60 | 64.5 | 1.99 | 1.30 | 64.7 | 1.99 | 1.30 | 64.8 | 1.99 | 1.31 | 65.0 | 1.99 | 1.31 | 65.1 | 1.99 | 1.31 | 65.2 | 1.99 | 1.31 | 65.4 | 1.99 | 1.32 | 65.5 | 1.99 | 1.32 | 65.7 | 1.99 | 1.32 | 65.8 | 1.99 | 1.33 |
| 13.70 | 64.5 | 1.99 | 1.30 | 64.7 | 1.99 | 1.30 | 64.8 | 1.99 | 1.30 | 65.0 | 1.99 | 1.31 | 65.1 | 1.99 | 1.31 | 65.3 | 1.99 | 1.31 | 65.4 | 1.99 | 1.32 | 65.6 | 1.99 | 1.32 | 65.7 | 1.99 | 1.32 | 65.9 | 1.99 | 1.32 |
| 13.80 | 64.6 | 2.00 | 1.30 | 64.7 | 2.00 | 1.30 | 64.9 | 2.00 | 1.30 | 65.0 | 2.00 | 1.30 | 65.1 | 2.00 | 1.31 | 65.3 | 2.00 | 1.31 | 65.4 | 2.00 | 1.31 | 65.6 | 2.00 | 1.32 | 65.7 | 2.00 | 1.32 | 65.9 | 2.00 | 1.32 |
| 13.90 | 64.6 | 2.00 | 1.29 | 64.7 | 2.00 | 1.30 | 64.9 | 2.00 | 1.30 | 65.0 | 2.00 | 1.30 | 65.2 | 2.00 | 1.31 | 65.3 | 2.00 | 1.31 | 65.5 | 2.00 | 1.31 | 65.6 | 2.00 | 1.31 | 65.8 | 2.00 | 1.32 | 65.9 | 2.00 | 1.32 |
| 14.00 | 64.6 | 2.00 | 1.29 | 64.8 | 2.00 | 1.30 | 64.9 | 2.00 | 1.30 | 65.1 | 2.00 | 1.30 | 65.2 | 2.00 | 1.30 | 65.4 | 2.00 | 1.31 | 65.5 | 2.00 | 1.31 | 65.7 | 2.00 | 1.31 | 65.8 | 2.00 | 1.32 | 66.0 | 2.00 | 1.32 |
| 14.10 | 64.6 | 2.00 | 1.29 | 64.8 | 2.00 | 1.29 | 64.9 | 2.00 | 1.30 | 65.1 | 2.00 | 1.30 | 65.2 | 2.00 | 1.30 | 65.4 | 2.00 | 1.31 | 65.5 | 2.00 | 1.31 | 65.7 | 2.00 | 1.31 | 65.8 | 2.00 | 1.31 | 66.0 | 2.00 | 1.32 |
| 14.20 | 64.6 | 2.00 | 1.29 | 64.8 | 2.00 | 1.29 | 64.9 | 2.00 | 1.29 | 65.1 | 2.00 | 1.30 | 65.3 | 2.00 | 1.30 | 65.4 | 2.00 | 1.30 | 65.6 | 2.00 | 1.31 | 65.7 | 2.00 | 1.31 | 65.9 | 2.00 | 1.31 | 66.0 | 2.00 | 1.32 |
| 14.30 | 64.7 | 2.01 | 1.29 | 64.8 | 2.01 | 1.29 | 65.0 | 2.01 | 1.29 | 65.1 | 2.01 | 1.30 | 65.3 | 2.01 | 1.30 | 65.4 | 2.01 | 1.30 | 65.6 | 2.01 | 1.30 | 65.7 | 2.01 | 1.31 | 65.9 | 2.01 | 1.31 | 66.0 | 2.01 | 1.31 |
| 14.40 | 64.7 | 2.01 | 1.28 | 64.8 | 2.01 | 1.29 | 65.0 | 2.01 | 1.29 | 65.2 | 2.01 | 1.29 | 65.3 | 2.01 | 1.30 | 65.5 | 2.01 | 1.30 | 65.6 | 2.01 | 1.30 | 65.8 | 2.01 | 1.31 | 65.9 | 2.01 | 1.31 | 66.1 | 2.01 | 1.31 |
| 14.50 | 64.7 | 2.01 | 1.28 | 64.9 | 2.01 | 1.29 | 65.0 | 2.01 | 1.29 | 65.2 | 2.01 | 1.29 | 65.3 | 2.01 | 1.29 | 65.5 | 2.01 | 1.30 | 65.6 | 2.01 | 1.30 | 65.8 | 2.01 | 1.30 | 65.9 | 2.01 | 1.31 | 66.1 | 2.01 | 1.31 |
| 14.60 | 64.7 | 2.01 | 1.28 | 64.9 | 2.01 | 1.28 | 65.0 | 2.01 | 1.29 | 65.2 | 2.01 | 1.29 | 65.4 | 2.01 | 1.29 | 65.5 | 2.01 | 1.30 | 65.7 | 2.01 | 1.30 | 65.8 | 2.01 | 1.30 | 66.0 | 2.01 | 1.31 | 66.1 | 2.01 | 1.31 |
| 14.70 | 64.8 | 2.02 | 1.28 | 64.9 | 2.02 | 1.28 | 65.1 | 2.02 | 1.29 | 65.2 | 2.02 | 1.29 | 65.4 | 2.02 | 1.29 | 65.5 | 2.02 | 1.29 | 65.7 | 2.02 | 1.30 | 65.8 | 2.02 | 1.30 | 66.0 | 2.02 | 1.30 | 66.1 | 2.02 | 1.31 |
| 14.80 | 64.8 | 2.02 | 1.28 | 64.9 | 2.02 | 1.28 | 65.1 | 2.02 | 1.28 | 65.3 | 2.02 | 1.29 | 65.4 | 2.02 | 1.29 | 65.6 | 2.02 | 1.29 | 65.7 | 2.02 | 1.30 | 65.9 | 2.02 | 1.30 | 66.0 | 2.02 | 1.30 | 66.2 | 2.02 | 1.30 |
| 14.90 | 64.8 | 2.02 | 1.28 | 65.0 | 2.02 | 1.28 | 65.1 | 2.02 | 1.28 | 65.3 | 2.02 | 1.28 | 65.4 | 2.02 | 1.29 | 65.6 | 2.02 | 1.29 | 65.7 | 2.02 | 1.29 | 65.9 | 2.02 | 1.30 | 66.0 | 2.02 | 1.30 | 66.2 | 2.02 | 1.30 |
| 15.00 | 64.8 | 2.02 | 1.27 | 65.0 | 2.02 | 1.28 | 65.2 | 2.02 | 1.28 | 65.3 | 2.02 | 1.28 | 65.5 | 2.02 | 1.29 | 65.6 | 2.02 | 1.29 | 65.8 | 2.02 | 1.29 | 65.9 | 2.02 | 1.29 | 66.1 | 2.02 | 1.30 | 66.2 | 2.02 | 1.30 |
| 15.10 | 64.9 | 2.03 | 1.27 | 65.0 | 2.03 | 1.27 | 65.2 | 2.03 | 1.28 | 65.3 | 2.03 | 1.28 | 65.5 | 2.03 | 1.28 | 65.6 | 2.03 | 1.29 | 65.8 | 2.03 | 1.29 | 65.9 | 2.03 | 1.29 | 66.1 | 2.03 | 1.30 | 66.2 | 2.03 | 1.30 |
| 15.20 | 64.9 | 2.03 | 1.27 | 65.0 | 2.03 | 1.27 | 65.2 | 2.03 | 1.28 | 65.4 | 2.03 | 1.28 | 65.5 | 2.03 | 1.28 | 65.7 | 2.03 | 1.28 | 65.8 | 2.03 | 1.29 | 66.0 | 2.03 | 1.29 | 66.1 | 2.03 | 1.29 | 66.3 | 2.03 | 1.30 |
| 15.30 | 64.9 | 2.03 | 1.27 | 65.1 | 2.03 | 1.27 | 65.2 | 2.03 | 1.27 | 65.4 | 2.03 | 1.28 | 65.5 | 2.03 | 1.28 | 65.7 | 2.03 | 1.28 | 65.8 | 2.03 | 1.29 | 66.0 | 2.03 | 1.29 | 66.1 | 2.03 | 1.29 | 66.3 | 2.03 | 1.30 |
| 15.40 | 64.9 | 2.03 | 1.27 | 65.1 | 2.03 | 1.27 | 65.3 | 2.03 | 1.27 | 65.4 | 2.03 | 1.28 | 65.6 | 2.03 | 1.28 | 65.7 | 2.03 | 1.28 | 65.9 | 2.03 | 1.28 | 66.0 | 2.03 | 1.29 | 66.2 | 2.03 | 1.29 | 66.3 | 2.03 | 1.29 |
| 15.50 | 65.0 | 2.04 | 1.26 | 65.1 | 2.04 | 1.27 | 65.3 | 2.04 | 1.27 | 65.4 | 2.04 | 1.27 | 65.6 | 2.04 | 1.28 | 65.7 | 2.04 | 1.28 | 65.9 | 2.04 | 1.28 | 66.0 | 2.04 | 1.29 | 66.2 | 2.04 | 1.29 | 66.3 | 2.04 | 1.29 |
| 15.60 | 65.0 | 2.04 | 1.26 | 65.2 | 2.04 | 1.27 | 65.3 | 2.04 | 1.27 | 65.5 | 2.04 | 1.27 | 65.6 | 2.04 | 1.27 | 65.8 | 2.04 | 1.28 | 65.9 | 2.04 | 1.28 | 66.1 | 2.04 | 1.28 | 66.2 | 2.04 | 1.29 | 66.4 | 2.04 | 1.29 |
| 15.70 | 65.0 | 2.04 | 1.26 | 65.2 | 2.04 | 1.26 | 65.3 | 2.04 | 1.27 | 65.5 | 2.04 | 1.27 | 65.6 | 2.04 | 1.27 | 65.8 | 2.04 | 1.28 | 65.9 | 2.04 | 1.28 | 66.1 | 2.04 | 1.28 | 66.2 | 2.04 | 1.28 | 66.4 | 2.04 | 1.29 |
| 15.80 | 65.0 | 2.04 | 1.26 | 65.2 | 2.04 | 1.26 | 65.4 | 2.04 | 1.26 | 65.5 | 2.04 | 1.27 | 65.7 | 2.04 | 1.27 | 65.8 | 2.04 | 1.27 | 66.0 | 2.04 | 1.28 | 66.1 | 2.04 | 1.28 | 66.3 | 2.04 | 1.28 | 66.4 | 2.04 | 1.29 |
| 15.90 | 65.1 | 2.05 | 1.26 | 65.2 | 2.05 | 1.26 | 65.4 | 2.05 | 1.26 | 65.5 | 2.05 | 1.27 | 65.7 | 2.05 | 1.27 | 65.8 | 2.05 | 1.27 | 66.0 | 2.05 | 1.27 | 66.1 | 2.05 | 1.28 | 66.3 | 2.05 | 1.28 | 66.5 | 2.05 | 1.28 |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 2.0; Water (ml) = (% Absorption x 2.0 / 100) + (2.0 - sample weight)

## 2-gram Mixograph: Absorption, Flour and Water Amount Table
## (15.0 - 15.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 15.00 | | | 15.10 | | | 15.20 | | | 15.30 | | | 15.40 | | | 15.50 | | | 15.60 | | | 15.70 | | | 15.80 | | | 15.90 | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml |
| 9.00 | 64.9 | 1.89 | 1.41 | 65.0 | 1.89 | 1.41 | 65.1 | 1.89 | 1.41 | 65.3 | 1.89 | 1.42 | 65.4 | 1.89 | 1.42 | 65.6 | 1.89 | 1.42 | 65.7 | 1.89 | 1.42 | 65.9 | 1.89 | 1.43 | 66.0 | 1.89 | 1.43 | 66.1 | 1.89 | 1.43 |
| 9.10 | 64.9 | 1.89 | 1.41 | 65.0 | 1.89 | 1.41 | 65.2 | 1.89 | 1.41 | 65.3 | 1.89 | 1.41 | 65.5 | 1.89 | 1.42 | 65.6 | 1.89 | 1.42 | 65.7 | 1.89 | 1.42 | 65.9 | 1.89 | 1.43 | 66.0 | 1.89 | 1.43 | 66.2 | 1.89 | 1.43 |
| 9.20 | 64.9 | 1.89 | 1.40 | 65.1 | 1.89 | 1.41 | 65.2 | 1.89 | 1.41 | 65.3 | 1.89 | 1.41 | 65.5 | 1.89 | 1.42 | 65.6 | 1.89 | 1.42 | 65.8 | 1.89 | 1.42 | 65.9 | 1.89 | 1.42 | 66.0 | 1.89 | 1.43 | 66.2 | 1.89 | 1.43 |
| 9.30 | 64.9 | 1.90 | 1.40 | 65.1 | 1.90 | 1.41 | 65.2 | 1.90 | 1.41 | 65.4 | 1.90 | 1.41 | 65.5 | 1.90 | 1.41 | 65.6 | 1.90 | 1.42 | 65.8 | 1.90 | 1.42 | 65.9 | 1.90 | 1.42 | 66.1 | 1.90 | 1.43 | 66.2 | 1.90 | 1.43 |
| 9.40 | 65.0 | 1.90 | 1.40 | 65.1 | 1.90 | 1.40 | 65.2 | 1.90 | 1.41 | 65.4 | 1.90 | 1.41 | 65.5 | 1.90 | 1.41 | 65.7 | 1.90 | 1.41 | 65.8 | 1.90 | 1.42 | 66.0 | 1.90 | 1.42 | 66.1 | 1.90 | 1.42 | 66.2 | 1.90 | 1.43 |
| 9.50 | 65.0 | 1.90 | 1.40 | 65.1 | 1.90 | 1.40 | 65.3 | 1.90 | 1.40 | 65.4 | 1.90 | 1.41 | 65.6 | 1.90 | 1.41 | 65.7 | 1.90 | 1.41 | 65.8 | 1.90 | 1.42 | 66.0 | 1.90 | 1.42 | 66.1 | 1.90 | 1.42 | 66.3 | 1.90 | 1.42 |
| 9.60 | 65.0 | 1.90 | 1.40 | 65.1 | 1.90 | 1.40 | 65.3 | 1.90 | 1.40 | 65.4 | 1.90 | 1.41 | 65.6 | 1.90 | 1.41 | 65.7 | 1.90 | 1.41 | 65.9 | 1.90 | 1.41 | 66.0 | 1.90 | 1.42 | 66.1 | 1.90 | 1.42 | 66.3 | 1.90 | 1.42 |
| 9.70 | 65.0 | 1.90 | 1.40 | 65.2 | 1.90 | 1.40 | 65.3 | 1.90 | 1.40 | 65.5 | 1.90 | 1.40 | 65.6 | 1.90 | 1.41 | 65.7 | 1.90 | 1.41 | 65.9 | 1.90 | 1.41 | 66.0 | 1.90 | 1.42 | 66.2 | 1.90 | 1.42 | 66.3 | 1.90 | 1.42 |
| 9.80 | 65.1 | 1.91 | 1.39 | 65.2 | 1.91 | 1.40 | 65.3 | 1.91 | 1.40 | 65.5 | 1.91 | 1.40 | 65.6 | 1.91 | 1.41 | 65.8 | 1.91 | 1.41 | 65.9 | 1.91 | 1.41 | 66.1 | 1.91 | 1.41 | 66.2 | 1.91 | 1.42 | 66.3 | 1.91 | 1.42 |
| 9.90 | 65.1 | 1.91 | 1.39 | 65.2 | 1.91 | 1.40 | 65.4 | 1.91 | 1.40 | 65.5 | 1.91 | 1.40 | 65.6 | 1.91 | 1.40 | 65.8 | 1.91 | 1.41 | 65.9 | 1.91 | 1.41 | 66.1 | 1.91 | 1.41 | 66.2 | 1.91 | 1.42 | 66.4 | 1.91 | 1.42 |
| 10.00 | 65.1 | 1.91 | 1.39 | 65.2 | 1.91 | 1.39 | 65.4 | 1.91 | 1.40 | 65.5 | 1.91 | 1.40 | 65.7 | 1.91 | 1.40 | 65.8 | 1.91 | 1.41 | 66.0 | 1.91 | 1.41 | 66.1 | 1.91 | 1.41 | 66.2 | 1.91 | 1.41 | 66.4 | 1.91 | 1.42 |
| 10.10 | 65.1 | 1.91 | 1.39 | 65.3 | 1.91 | 1.39 | 65.4 | 1.91 | 1.39 | 65.6 | 1.91 | 1.40 | 65.7 | 1.91 | 1.40 | 65.8 | 1.91 | 1.40 | 66.0 | 1.91 | 1.41 | 66.1 | 1.91 | 1.41 | 66.3 | 1.91 | 1.41 | 66.4 | 1.91 | 1.42 |
| 10.20 | 65.1 | 1.92 | 1.39 | 65.3 | 1.92 | 1.39 | 65.4 | 1.92 | 1.39 | 65.6 | 1.92 | 1.40 | 65.7 | 1.92 | 1.40 | 65.9 | 1.92 | 1.40 | 66.0 | 1.92 | 1.40 | 66.2 | 1.92 | 1.41 | 66.3 | 1.92 | 1.41 | 66.4 | 1.92 | 1.41 |
| 10.30 | 65.2 | 1.92 | 1.39 | 65.3 | 1.92 | 1.39 | 65.5 | 1.92 | 1.39 | 65.6 | 1.92 | 1.39 | 65.7 | 1.92 | 1.40 | 65.9 | 1.92 | 1.40 | 66.0 | 1.92 | 1.40 | 66.2 | 1.92 | 1.41 | 66.3 | 1.92 | 1.41 | 66.5 | 1.92 | 1.41 |
| 10.40 | 65.2 | 1.92 | 1.38 | 65.3 | 1.92 | 1.39 | 65.5 | 1.92 | 1.39 | 65.6 | 1.92 | 1.39 | 65.8 | 1.92 | 1.40 | 65.9 | 1.92 | 1.40 | 66.1 | 1.92 | 1.40 | 66.2 | 1.92 | 1.40 | 66.3 | 1.92 | 1.41 | 66.5 | 1.92 | 1.41 |
| 10.50 | 65.2 | 1.92 | 1.38 | 65.4 | 1.92 | 1.39 | 65.5 | 1.92 | 1.39 | 65.7 | 1.92 | 1.39 | 65.8 | 1.92 | 1.39 | 65.9 | 1.92 | 1.40 | 66.1 | 1.92 | 1.40 | 66.2 | 1.92 | 1.40 | 66.4 | 1.92 | 1.41 | 66.5 | 1.92 | 1.41 |
| 10.60 | 65.2 | 1.92 | 1.38 | 65.4 | 1.92 | 1.38 | 65.5 | 1.92 | 1.39 | 65.7 | 1.92 | 1.39 | 65.8 | 1.92 | 1.39 | 66.0 | 1.92 | 1.40 | 66.1 | 1.92 | 1.40 | 66.3 | 1.92 | 1.40 | 66.4 | 1.92 | 1.40 | 66.5 | 1.92 | 1.41 |
| 10.70 | 65.3 | 1.93 | 1.38 | 65.4 | 1.93 | 1.38 | 65.6 | 1.93 | 1.39 | 65.7 | 1.93 | 1.39 | 65.8 | 1.93 | 1.39 | 66.0 | 1.93 | 1.39 | 66.1 | 1.93 | 1.40 | 66.3 | 1.93 | 1.40 | 66.4 | 1.93 | 1.40 | 66.6 | 1.93 | 1.41 |
| 10.80 | 65.3 | 1.93 | 1.38 | 64.8 | 1.93 | 1.37 | 65.6 | 1.93 | 1.38 | 65.7 | 1.93 | 1.39 | 65.9 | 1.93 | 1.39 | 66.0 | 1.93 | 1.39 | 65.6 | 1.93 | 1.38 | 66.3 | 1.93 | 1.40 | 66.4 | 1.93 | 1.40 | 66.6 | 1.93 | 1.40 |
| 10.90 | 65.3 | 1.93 | 1.38 | 65.5 | 1.93 | 1.38 | 65.6 | 1.93 | 1.38 | 65.8 | 1.93 | 1.38 | 65.9 | 1.93 | 1.39 | 66.0 | 1.93 | 1.39 | 66.2 | 1.93 | 1.39 | 66.3 | 1.93 | 1.40 | 66.5 | 1.93 | 1.40 | 66.6 | 1.93 | 1.40 |
| 11.00 | 65.3 | 1.93 | 1.37 | 65.5 | 1.93 | 1.38 | 65.6 | 1.93 | 1.38 | 65.8 | 1.93 | 1.38 | 65.9 | 1.93 | 1.39 | 66.1 | 1.93 | 1.39 | 66.2 | 1.93 | 1.39 | 66.4 | 1.93 | 1.39 | 66.5 | 1.93 | 1.40 | 66.6 | 1.93 | 1.40 |
| 11.10 | 65.4 | 1.93 | 1.37 | 65.5 | 1.93 | 1.38 | 65.7 | 1.93 | 1.38 | 65.8 | 1.93 | 1.38 | 65.9 | 1.93 | 1.38 | 66.1 | 1.93 | 1.39 | 66.2 | 1.93 | 1.39 | 66.4 | 1.93 | 1.39 | 66.5 | 1.93 | 1.40 | 66.7 | 1.93 | 1.40 |
| 11.20 | 65.4 | 1.94 | 1.37 | 65.5 | 1.94 | 1.37 | 65.7 | 1.94 | 1.38 | 65.8 | 1.94 | 1.38 | 66.0 | 1.94 | 1.38 | 66.1 | 1.94 | 1.39 | 66.3 | 1.94 | 1.39 | 66.4 | 1.94 | 1.39 | 66.6 | 1.94 | 1.39 | 66.7 | 1.94 | 1.40 |
| 11.30 | 65.4 | 1.94 | 1.37 | 65.6 | 1.94 | 1.37 | 65.7 | 1.94 | 1.37 | 65.9 | 1.94 | 1.38 | 66.0 | 1.94 | 1.38 | 66.1 | 1.94 | 1.38 | 66.3 | 1.94 | 1.39 | 66.4 | 1.94 | 1.39 | 66.6 | 1.94 | 1.39 | 66.7 | 1.94 | 1.40 |
| 11.40 | 65.4 | 1.94 | 1.37 | 65.6 | 1.94 | 1.37 | 65.7 | 1.94 | 1.37 | 65.9 | 1.94 | 1.38 | 66.0 | 1.94 | 1.38 | 66.2 | 1.94 | 1.38 | 66.3 | 1.94 | 1.38 | 66.5 | 1.94 | 1.39 | 66.6 | 1.94 | 1.39 | 66.8 | 1.94 | 1.39 |
| 11.50 | 65.5 | 1.94 | 1.37 | 65.6 | 1.94 | 1.37 | 65.8 | 1.94 | 1.37 | 65.9 | 1.94 | 1.37 | 66.0 | 1.94 | 1.38 | 66.2 | 1.94 | 1.38 | 66.3 | 1.94 | 1.38 | 66.5 | 1.94 | 1.39 | 66.6 | 1.94 | 1.39 | 66.8 | 1.94 | 1.39 |
| 11.60 | 65.5 | 1.95 | 1.36 | 65.6 | 1.95 | 1.37 | 65.8 | 1.95 | 1.37 | 65.9 | 1.95 | 1.37 | 66.1 | 1.95 | 1.38 | 66.2 | 1.95 | 1.38 | 66.4 | 1.95 | 1.38 | 66.5 | 1.95 | 1.38 | 66.7 | 1.95 | 1.39 | 66.8 | 1.95 | 1.39 |
| 11.70 | 65.5 | 1.95 | 1.36 | 65.7 | 1.95 | 1.37 | 65.8 | 1.95 | 1.37 | 66.0 | 1.95 | 1.37 | 66.1 | 1.95 | 1.37 | 66.2 | 1.95 | 1.38 | 66.4 | 1.95 | 1.38 | 66.5 | 1.95 | 1.38 | 66.7 | 1.95 | 1.39 | 66.8 | 1.95 | 1.39 |
| 11.80 | 65.5 | 1.95 | 1.36 | 65.7 | 1.95 | 1.36 | 65.8 | 1.95 | 1.37 | 66.0 | 1.95 | 1.37 | 66.1 | 1.95 | 1.37 | 66.3 | 1.95 | 1.38 | 66.4 | 1.95 | 1.38 | 66.6 | 1.95 | 1.38 | 66.7 | 1.95 | 1.38 | 66.9 | 1.95 | 1.39 |
| 11.90 | 65.6 | 1.95 | 1.36 | 65.7 | 1.95 | 1.36 | 65.9 | 1.95 | 1.36 | 66.0 | 1.95 | 1.37 | 66.1 | 1.95 | 1.37 | 66.3 | 1.95 | 1.37 | 66.4 | 1.95 | 1.38 | 66.6 | 1.95 | 1.38 | 66.7 | 1.95 | 1.38 | 66.9 | 1.95 | 1.39 |
| 12.00 | 65.6 | 1.95 | 1.36 | 65.7 | 1.95 | 1.36 | 65.9 | 1.95 | 1.36 | 66.0 | 1.95 | 1.37 | 66.2 | 1.95 | 1.37 | 66.3 | 1.95 | 1.37 | 66.5 | 1.95 | 1.37 | 66.6 | 1.95 | 1.38 | 66.8 | 1.95 | 1.38 | 66.9 | 1.95 | 1.38 |
| 12.10 | 65.6 | 1.96 | 1.36 | 65.8 | 1.96 | 1.36 | 65.9 | 1.96 | 1.36 | 66.1 | 1.96 | 1.36 | 66.2 | 1.96 | 1.37 | 66.3 | 1.96 | 1.37 | 66.5 | 1.96 | 1.37 | 66.6 | 1.96 | 1.38 | 66.8 | 1.96 | 1.38 | 66.9 | 1.96 | 1.38 |
| 12.30 | 65.7 | 1.96 | 1.35 | 65.8 | 1.96 | 1.35 | 66.0 | 1.96 | 1.36 | 66.1 | 1.96 | 1.36 | 66.3 | 1.96 | 1.36 | 66.4 | 1.96 | 1.37 | 66.5 | 1.96 | 1.37 | 66.7 | 1.96 | 1.37 | 66.8 | 1.96 | 1.38 | 67.0 | 1.96 | 1.38 |
| 12.30 | 65.7 | 1.96 | 1.35 | 65.8 | 1.96 | 1.35 | 66.0 | 1.96 | 1.36 | 66.1 | 1.96 | 1.36 | 66.3 | 1.96 | 1.36 | 66.4 | 1.96 | 1.37 | 66.5 | 1.96 | 1.37 | 66.7 | 1.96 | 1.37 | 66.8 | 1.96 | 1.38 | 67.0 | 1.96 | 1.38 |
| 12.40 | 65.7 | 1.96 | 1.35 | 65.8 | 1.96 | 1.35 | 66.0 | 1.96 | 1.36 | 66.1 | 1.96 | 1.36 | 66.3 | 1.96 | 1.36 | 66.4 | 1.96 | 1.37 | 66.6 | 1.96 | 1.37 | 66.7 | 1.96 | 1.37 | 66.9 | 1.96 | 1.37 | 67.0 | 1.96 | 1.38 |
| 12.50 | 65.7 | 1.97 | 1.35 | 65.9 | 1.97 | 1.35 | 66.0 | 1.97 | 1.35 | 66.2 | 1.97 | 1.36 | 66.3 | 1.97 | 1.36 | 66.5 | 1.97 | 1.36 | 66.6 | 1.97 | 1.37 | 66.7 | 1.97 | 1.37 | 66.9 | 1.97 | 1.37 | 67.0 | 1.97 | 1.38 |
| 12.60 | 65.7 | 1.97 | 1.35 | 65.9 | 1.97 | 1.35 | 66.0 | 1.97 | 1.35 | 66.2 | 1.97 | 1.36 | 66.3 | 1.97 | 1.36 | 66.5 | 1.97 | 1.36 | 66.6 | 1.97 | 1.36 | 66.8 | 1.97 | 1.37 | 66.9 | 1.97 | 1.37 | 67.1 | 1.97 | 1.37 |
| 12.70 | 65.8 | 1.97 | 1.35 | 65.9 | 1.97 | 1.35 | 66.1 | 1.97 | 1.35 | 66.2 | 1.97 | 1.35 | 66.4 | 1.97 | 1.36 | 66.5 | 1.97 | 1.36 | 66.7 | 1.97 | 1.36 | 66.8 | 1.97 | 1.37 | 66.9 | 1.97 | 1.37 | 67.1 | 1.97 | 1.37 |
| 12.80 | 65.8 | 1.97 | 1.34 | 65.9 | 1.97 | 1.35 | 66.1 | 1.97 | 1.35 | 66.2 | 1.97 | 1.35 | 66.4 | 1.97 | 1.36 | 66.5 | 1.97 | 1.36 | 66.7 | 1.97 | 1.36 | 66.8 | 1.97 | 1.36 | 67.0 | 1.97 | 1.37 | 67.1 | 1.97 | 1.37 |
| 12.90 | 65.8 | 1.97 | 1.34 | 66.0 | 1.97 | 1.34 | 66.1 | 1.97 | 1.35 | 66.3 | 1.97 | 1.35 | 66.4 | 1.97 | 1.35 | 66.6 | 1.97 | 1.36 | 66.7 | 1.97 | 1.36 | 66.9 | 1.97 | 1.36 | 67.0 | 1.97 | 1.37 | 67.1 | 1.97 | 1.37 |
| 13.00 | 65.8 | 1.98 | 1.34 | 66.0 | 1.98 | 1.34 | 66.1 | 1.98 | 1.35 | 66.3 | 1.98 | 1.35 | 66.4 | 1.98 | 1.35 | 66.6 | 1.98 | 1.35 | 66.7 | 1.98 | 1.36 | 66.9 | 1.98 | 1.36 | 67.0 | 1.98 | 1.36 | 67.2 | 1.98 | 1.37 |
| 13.10 | 65.9 | 1.98 | 1.34 | 66.0 | 1.98 | 1.34 | 66.2 | 1.98 | 1.34 | 66.3 | 1.98 | 1.35 | 66.5 | 1.98 | 1.35 | 66.6 | 1.98 | 1.35 | 66.8 | 1.98 | 1.36 | 66.9 | 1.98 | 1.36 | 67.1 | 1.98 | 1.36 | 67.2 | 1.98 | 1.36 |
| 13.20 | 65.9 | 1.98 | 1.34 | 66.0 | 1.98 | 1.34 | 66.2 | 1.98 | 1.34 | 66.3 | 1.98 | 1.35 | 66.5 | 1.98 | 1.35 | 66.6 | 1.98 | 1.35 | 66.8 | 1.98 | 1.35 | 66.9 | 1.98 | 1.36 | 67.1 | 1.98 | 1.36 | 67.2 | 1.98 | 1.36 |
| 13.30 | 65.9 | 1.98 | 1.33 | 66.1 | 1.98 | 1.34 | 66.2 | 1.98 | 1.34 | 66.4 | 1.98 | 1.34 | 66.5 | 1.98 | 1.35 | 66.7 | 1.98 | 1.35 | 66.8 | 1.98 | 1.35 | 67.0 | 1.98 | 1.36 | 67.1 | 1.98 | 1.36 | 67.3 | 1.98 | 1.36 |
| 13.40 | 65.9 | 1.99 | 1.33 | 66.1 | 1.99 | 1.34 | 66.2 | 1.99 | 1.34 | 66.4 | 1.99 | 1.34 | 66.5 | 1.99 | 1.34 | 66.7 | 1.99 | 1.35 | 66.8 | 1.99 | 1.35 | 67.0 | 1.99 | 1.35 | 67.1 | 1.99 | 1.36 | 67.3 | 1.99 | 1.36 |
| 13.50 | 66.0 | 1.99 | 1.33 | 66.1 | 1.99 | 1.33 | 66.3 | 1.99 | 1.34 | 66.4 | 1.99 | 1.34 | 66.6 | 1.99 | 1.34 | 66.7 | 1.99 | 1.35 | 66.9 | 1.99 | 1.35 | 67.0 | 1.99 | 1.35 | 67.2 | 1.99 | 1.35 | 67.3 | 1.99 | 1.36 |
| 13.60 | 66.0 | 1.99 | 1.33 | 66.1 | 1.99 | 1.33 | 66.3 | 1.99 | 1.34 | 66.4 | 1.99 | 1.34 | 66.6 | 1.99 | 1.34 | 66.7 | 1.99 | 1.34 | 66.9 | 1.99 | 1.35 | 67.0 | 1.99 | 1.35 | 67.2 | 1.99 | 1.35 | 67.3 | 1.99 | 1.36 |
| 13.70 | 66.0 | 1.99 | 1.33 | 66.2 | 1.99 | 1.33 | 66.3 | 1.99 | 1.33 | 66.5 | 1.99 | 1.34 | 66.6 | 1.99 | 1.34 | 66.8 | 1.99 | 1.34 | 66.9 | 1.99 | 1.35 | 67.1 | 1.99 | 1.35 | 67.2 | 1.99 | 1.35 | 67.4 | 1.99 | 1.35 |
| 13.80 | 66.0 | 2.00 | 1.33 | 66.2 | 2.00 | 1.33 | 66.3 | 2.00 | 1.33 | 66.5 | 2.00 | 1.33 | 66.6 | 2.00 | 1.34 | 66.8 | 2.00 | 1.34 | 66.9 | 2.00 | 1.34 | 67.1 | 2.00 | 1.35 | 67.2 | 2.00 | 1.35 | 67.4 | 2.00 | 1.35 |
| 13.90 | 66.1 | 2.00 | 1.32 | 66.2 | 2.00 | 1.33 | 66.4 | 2.00 | 1.33 | 66.5 | 2.00 | 1.33 | 66.7 | 2.00 | 1.34 | 66.8 | 2.00 | 1.34 | 67.0 | 2.00 | 1.34 | 67.1 | 2.00 | 1.34 | 67.3 | 2.00 | 1.35 | 67.4 | 2.00 | 1.35 |
| 14.00 | 66.1 | 2.00 | 1.32 | 66.3 | 2.00 | 1.33 | 66.4 | 2.00 | 1.33 | 66.6 | 2.00 | 1.33 | 66.7 | 2.00 | 1.33 | 66.9 | 2.00 | 1.34 | 67.0 | 2.00 | 1.34 | 67.2 | 2.00 | 1.34 | 67.3 | 2.00 | 1.35 | 67.5 | 2.00 | 1.35 |
| 14.10 | 66.1 | 2.00 | 1.32 | 66.3 | 2.00 | 1.32 | 66.4 | 2.00 | 1.33 | 66.6 | 2.00 | 1.33 | 66.7 | 2.00 | 1.33 | 66.9 | 2.00 | 1.34 | 67.0 | 2.00 | 1.34 | 67.2 | 2.00 | 1.34 | 67.3 | 2.00 | 1.34 | 67.5 | 2.00 | 1.35 |
| 14.20 | 66.2 | 2.00 | 1.32 | 66.3 | 2.00 | 1.32 | 66.5 | 2.00 | 1.32 | 66.6 | 2.00 | 1.33 | 66.8 | 2.00 | 1.33 | 66.9 | 2.00 | 1.33 | 67.1 | 2.00 | 1.34 | 67.2 | 2.00 | 1.34 | 67.4 | 2.00 | 1.34 | 67.5 | 2.00 | 1.35 |
| 14.30 | 66.2 | 2.01 | 1.32 | 66.3 | 2.01 | 1.32 | 66.5 | 2.01 | 1.32 | 66.6 | 2.01 | 1.33 | 66.8 | 2.01 | 1.33 | 66.9 | 2.01 | 1.33 | 67.1 | 2.01 | 1.33 | 67.2 | 2.01 | 1.34 | 67.4 | 2.01 | 1.34 | 67.5 | 2.01 | 1.34 |
| 14.40 | 66.2 | 2.01 | 1.31 | 66.4 | 2.01 | 1.32 | 66.5 | 2.01 | 1.32 | 66.7 | 2.01 | 1.32 | 66.8 | 2.01 | 1.33 | 67.0 | 2.01 | 1.33 | 67.1 | 2.01 | 1.33 | 67.3 | 2.01 | 1.34 | 67.4 | 2.01 | 1.34 | 67.6 | 2.01 | 1.34 |
| 14.50 | 66.2 | 2.01 | 1.31 | 66.4 | 2.01 | 1.32 | 66.5 | 2.01 | 1.32 | 66.7 | 2.01 | 1.32 | 66.8 | 2.01 | 1.33 | 67.0 | 2.01 | 1.33 | 67.1 | 2.01 | 1.33 | 67.3 | 2.01 | 1.33 | 67.4 | 2.01 | 1.34 | 67.6 | 2.01 | 1.34 |
| 14.60 | 66.3 | 2.01 | 1.31 | 66.4 | 2.01 | 1.31 | 66.6 | 2.01 | 1.32 | 66.7 | 2.01 | 1.32 | 66.9 | 2.01 | 1.32 | 67.0 | 2.01 | 1.33 | 67.2 | 2.01 | 1.33 | 67.3 | 2.01 | 1.33 | 67.5 | 2.01 | 1.34 | 67.6 | 2.01 | 1.34 |
| 14.70 | 66.3 | 2.02 | 1.31 | 66.4 | 2.02 | 1.31 | 66.6 | 2.02 | 1.32 | 66.7 | 2.02 | 1.32 | 66.9 | 2.02 | 1.32 | 67.0 | 2.02 | 1.32 | 67.2 | 2.02 | 1.33 | 67.3 | 2.02 | 1.33 | 67.5 | 2.02 | 1.33 | 67.6 | 2.02 | 1.34 |
| 14.80 | 66.3 | 2.02 | 1.31 | 66.5 | 2.02 | 1.31 | 66.6 | 2.02 | 1.31 | 66.8 | 2.02 | 1.32 | 66.9 | 2.02 | 1.32 | 67.1 | 2.02 | 1.32 | 67.2 | 2.02 | 1.33 | 67.4 | 2.02 | 1.33 | 67.5 | 2.02 | 1.33 | 67.7 | 2.02 | 1.33 |
| 14.90 | 66.3 | 2.02 | 1.31 | 66.5 | 2.02 | 1.31 | 66.6 | 2.02 | 1.31 | 66.8 | 2.02 | 1.31 | 66.9 | 2.02 | 1.32 | 67.1 | 2.02 | 1.32 | 67.2 | 2.02 | 1.32 | 67.4 | 2.02 | 1.33 | 67.6 | 2.02 | 1.33 | 67.7 | 2.02 | 1.33 |
| 15.00 | 66.4 | 2.02 | 1.30 | 66.5 | 2.02 | 1.31 | 66.7 | 2.02 | 1.31 | 66.8 | 2.02 | 1.31 | 67.0 | 2.02 | 1.32 | 67.1 | 2.02 | 1.32 | 67.3 | 2.02 | 1.32 | 67.4 | 2.02 | 1.33 | 67.6 | 2.02 | 1.33 | 67.7 | 2.02 | 1.33 |
| 15.10 | 66.4 | 2.03 | 1.30 | 66.5 | 2.03 | 1.30 | 66.7 | 2.03 | 1.31 | 66.8 | 2.03 | 1.31 | 67.0 | 2.03 | 1.31 | 67.2 | 2.03 | 1.32 | 67.3 | 2.03 | 1.32 | 67.5 | 2.03 | 1.32 | 67.6 | 2.03 | 1.33 | 67.8 | 2.03 | 1.33 |
| 15.20 | 66.4 | 2.03 | 1.30 | 66.6 | 2.03 | 1.30 | 66.7 | 2.03 | 1.31 | 66.9 | 2.03 | 1.31 | 67.0 | 2.03 | 1.31 | 67.2 | 2.03 | 1.32 | 67.3 | 2.03 | 1.32 | 67.5 | 2.03 | 1.32 | 67.6 | 2.03 | 1.32 | 67.8 | 2.03 | 1.33 |
| 15.30 | 66.4 | 2.03 | 1.30 | 66.6 | 2.03 | 1.30 | 66.7 | 2.03 | 1.30 | 66.9 | 2.03 | 1.31 | 67.1 | 2.03 | 1.31 | 67.2 | 2.03 | 1.31 | 67.4 | 2.03 | 1.32 | 67.5 | 2.03 | 1.32 | 67.7 | 2.03 | 1.32 | 67.8 | 2.03 | 1.33 |
| 15.40 | 66.5 | 2.03 | 1.30 | 66.6 | 2.03 | 1.30 | 66.8 | 2.03 | 1.30 | 66.9 | 2.03 | 1.31 | 67.1 | 2.03 | 1.31 | 67.2 | 2.03 | 1.31 | 67.4 | 2.03 | 1.31 | 67.5 | 2.03 | 1.32 | 67.7 | 2.03 | 1.32 | 67.8 | 2.03 | 1.32 |
| 15.50 | 66.5 | 2.04 | 1.29 | 66.7 | 2.04 | 1.30 | 66.8 | 2.04 | 1.30 | 67.0 | 2.04 | 1.30 | 67.1 | 2.04 | 1.31 | 67.3 | 2.04 | 1.31 | 67.4 | 2.04 | 1.31 | 67.6 | 2.04 | 1.32 | 67.7 | 2.04 | 1.32 | 67.9 | 2.04 | 1.32 |
| 15.60 | 66.5 | 2.04 | 1.29 | 66.7 | 2.04 | 1.30 | 66.8 | 2.04 | 1.30 | 67.0 | 2.04 | 1.30 | 67.1 | 2.04 | 1.30 | 67.3 | 2.04 | 1.31 | 67.4 | 2.04 | 1.31 | 67.6 | 2.04 | 1.31 | 67.7 | 2.04 | 1.32 | 67.9 | 2.04 | 1.32 |
| 15.70 | 66.6 | 2.04 | 1.29 | 66.7 | 2.04 | 1.29 | 66.9 | 2.04 | 1.30 | 67.0 | 2.04 | 1.30 | 67.2 | 2.04 | 1.30 | 67.3 | 2.04 | 1.31 | 67.5 | 2.04 | 1.31 | 67.6 | 2.04 | 1.31 | 67.8 | 2.04 | 1.32 | 67.9 | 2.04 | 1.32 |
| 15.80 | 66.6 | 2.04 | 1.29 | 66.7 | 2.04 | 1.29 | 66.9 | 2.04 | 1.29 | 67.0 | 2.04 | 1.30 | 67.2 | 2.04 | 1.30 | 67.3 | 2.04 | 1.30 | 67.5 | 2.04 | 1.31 | 67.7 | 2.04 | 1.31 | 67.8 | 2.04 | 1.31 | 68.0 | 2.04 | 1.32 |
| 15.90 | 66.6 | 2.05 | 1.29 | 66.8 | 2.05 | 1.29 | 66.9 | 2.05 | 1.29 | 67.1 | 2.05 | 1.30 | 67.2 | 2.05 | 1.30 | 67.4 | 2.05 | 1.30 | 67.5 | 2.05 | 1.31 | 67.7 | 2.05 | 1.31 | 67.8 | 2.05 | 1.31 | 68.0 | 2.05 | 1.31 |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 2.0; Water (ml) = (% Absorption x 2.0 / 100) + (2.0 - sample weight)

# 10-gram Mixograph

Absorption, Flour and Water Amount Table

## 10-gram Mixograph: Absorption, Flour and Water Amount Table
## (8.0 - 8.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 8.00 | | | 8.10 | | | 8.20 | | | 8.30 | | | 8.40 | | | 8.50 | | | 8.60 | | | 8.70 | | | 8.80 | | | 8.90 | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml |
| 9.00 | 54.9 | 9.45 | 6.04 | 55.1 | 9.45 | 6.06 | 55.2 | 9.45 | 6.07 | 55.4 | 9.45 | 6.09 | 55.5 | 9.45 | 6.10 | 55.6 | 9.45 | 6.11 | 55.8 | 9.45 | 6.13 | 55.9 | 9.45 | 6.14 | 56.1 | 9.45 | 6.16 | 56.2 | 9.45 | 6.17 |
| 9.10 | 55.0 | 9.46 | 6.03 | 55.1 | 9.46 | 6.05 | 55.2 | 9.46 | 6.06 | 55.4 | 9.46 | 6.08 | 55.5 | 9.46 | 6.09 | 55.7 | 9.46 | 6.11 | 55.8 | 9.46 | 6.12 | 55.9 | 9.46 | 6.13 | 56.1 | 9.46 | 6.15 | 56.2 | 9.46 | 6.16 |
| 9.20 | 55.0 | 9.47 | 6.03 | 55.1 | 9.47 | 6.04 | 55.2 | 9.47 | 6.05 | 55.4 | 9.47 | 6.07 | 55.5 | 9.47 | 6.08 | 55.7 | 9.47 | 6.10 | 55.8 | 9.47 | 6.11 | 56.0 | 9.47 | 6.12 | 56.1 | 9.47 | 6.14 | 56.2 | 9.47 | 6.15 |
| 9.30 | 55.0 | 9.48 | 6.02 | 55.1 | 9.48 | 6.03 | 55.3 | 9.48 | 6.04 | 55.4 | 9.48 | 6.06 | 55.5 | 9.48 | 6.07 | 55.7 | 9.48 | 6.09 | 55.8 | 9.48 | 6.10 | 56.0 | 9.48 | 6.12 | 56.1 | 9.48 | 6.13 | 56.3 | 9.48 | 6.14 |
| 9.40 | 55.0 | 9.49 | 6.01 | 55.1 | 9.49 | 6.02 | 55.3 | 9.49 | 6.04 | 55.4 | 9.49 | 6.05 | 55.6 | 9.49 | 6.06 | 55.7 | 9.49 | 6.08 | 55.8 | 9.49 | 6.09 | 56.0 | 9.49 | 6.11 | 56.1 | 9.49 | 6.12 | 56.3 | 9.49 | 6.13 |
| 9.50 | 55.0 | 9.50 | 6.00 | 55.1 | 9.50 | 6.01 | 55.3 | 9.50 | 6.03 | 55.4 | 9.50 | 6.04 | 55.6 | 9.50 | 6.05 | 55.7 | 9.50 | 6.07 | 55.9 | 9.50 | 6.08 | 56.0 | 9.50 | 6.10 | 56.1 | 9.50 | 6.11 | 56.3 | 9.50 | 6.13 |
| 9.60 | 55.0 | 9.51 | 5.99 | 55.2 | 9.51 | 6.00 | 55.3 | 9.51 | 6.02 | 55.4 | 9.51 | 6.03 | 55.6 | 9.51 | 6.05 | 55.7 | 9.51 | 6.06 | 55.9 | 9.51 | 6.07 | 56.0 | 9.51 | 6.09 | 56.2 | 9.51 | 6.10 | 56.3 | 9.51 | 6.12 |
| 9.70 | 55.0 | 9.52 | 5.98 | 55.2 | 9.52 | 5.99 | 55.3 | 9.52 | 6.01 | 55.5 | 9.52 | 6.02 | 55.6 | 9.52 | 6.04 | 55.7 | 9.52 | 6.05 | 55.9 | 9.52 | 6.06 | 56.0 | 9.52 | 6.08 | 56.2 | 9.52 | 6.09 | 56.3 | 9.52 | 6.11 |
| 9.80 | 55.0 | 9.53 | 5.97 | 55.2 | 9.53 | 5.98 | 55.3 | 9.53 | 6.00 | 55.5 | 9.53 | 6.01 | 55.6 | 9.53 | 6.03 | 55.8 | 9.53 | 6.04 | 55.9 | 9.53 | 6.06 | 56.0 | 9.53 | 6.07 | 56.2 | 9.53 | 6.08 | 56.3 | 9.53 | 6.10 |
| 9.90 | 55.1 | 9.54 | 5.96 | 55.2 | 9.54 | 5.97 | 55.3 | 9.54 | 5.99 | 55.5 | 9.54 | 6.00 | 55.6 | 9.54 | 6.02 | 55.8 | 9.54 | 6.03 | 55.9 | 9.54 | 6.05 | 56.1 | 9.54 | 6.06 | 56.2 | 9.54 | 6.07 | 56.3 | 9.54 | 6.09 |
| 10.00 | 55.1 | 9.56 | 5.95 | 55.2 | 9.56 | 5.97 | 55.4 | 9.56 | 5.98 | 55.5 | 9.56 | 5.99 | 55.6 | 9.56 | 6.01 | 55.8 | 9.56 | 6.02 | 55.9 | 9.56 | 6.04 | 56.1 | 9.56 | 6.05 | 56.2 | 9.56 | 6.07 | 56.4 | 9.56 | 6.08 |
| 10.10 | 55.1 | 9.57 | 5.94 | 55.2 | 9.57 | 5.96 | 55.4 | 9.57 | 5.97 | 55.5 | 9.57 | 5.98 | 55.7 | 9.57 | 6.00 | 55.8 | 9.57 | 6.01 | 55.9 | 9.57 | 6.03 | 56.1 | 9.57 | 6.04 | 56.2 | 9.57 | 6.06 | 56.4 | 9.57 | 6.07 |
| 10.20 | 55.1 | 9.58 | 5.93 | 55.2 | 9.58 | 5.95 | 55.4 | 9.58 | 5.96 | 55.5 | 9.58 | 5.98 | 55.7 | 9.58 | 5.99 | 55.8 | 9.58 | 6.00 | 56.0 | 9.58 | 6.02 | 56.1 | 9.58 | 6.03 | 56.2 | 9.58 | 6.05 | 56.4 | 9.58 | 6.06 |
| 10.30 | 55.1 | 9.59 | 5.92 | 55.2 | 9.59 | 5.94 | 55.4 | 9.59 | 5.95 | 55.5 | 9.59 | 5.97 | 55.7 | 9.59 | 5.98 | 55.8 | 9.59 | 5.99 | 56.0 | 9.59 | 6.01 | 56.1 | 9.59 | 6.02 | 56.3 | 9.59 | 6.04 | 56.4 | 9.59 | 6.05 |
| 10.40 | 55.1 | 9.60 | 5.91 | 55.3 | 9.60 | 5.93 | 55.4 | 9.60 | 5.94 | 55.5 | 9.60 | 5.96 | 55.7 | 9.60 | 5.97 | 55.8 | 9.60 | 5.99 | 56.0 | 9.60 | 6.00 | 56.1 | 9.60 | 6.01 | 56.3 | 9.60 | 6.03 | 56.4 | 9.60 | 6.04 |
| 10.50 | 55.1 | 9.61 | 5.90 | 55.3 | 9.61 | 5.92 | 55.4 | 9.61 | 5.93 | 55.6 | 9.61 | 5.95 | 55.7 | 9.61 | 5.96 | 55.9 | 9.61 | 5.98 | 56.0 | 9.61 | 5.99 | 56.1 | 9.61 | 6.01 | 56.3 | 9.61 | 6.02 | 56.4 | 9.61 | 6.03 |
| 10.60 | 55.1 | 9.62 | 5.89 | 55.3 | 9.62 | 5.91 | 55.4 | 9.62 | 5.92 | 55.6 | 9.62 | 5.94 | 55.7 | 9.62 | 5.95 | 55.9 | 9.62 | 5.97 | 56.0 | 9.62 | 5.98 | 56.2 | 9.62 | 6.00 | 56.3 | 9.62 | 6.01 | 56.4 | 9.62 | 6.02 |
| 10.70 | 55.2 | 9.63 | 5.89 | 55.3 | 9.63 | 5.90 | 55.4 | 9.63 | 5.91 | 55.6 | 9.63 | 5.93 | 55.7 | 9.63 | 5.94 | 55.9 | 9.63 | 5.96 | 56.0 | 9.63 | 5.97 | 56.2 | 9.63 | 5.99 | 56.3 | 9.63 | 6.00 | 56.5 | 9.63 | 6.02 |
| 10.80 | 55.2 | 9.64 | 5.88 | 55.3 | 9.64 | 5.89 | 55.5 | 9.64 | 5.90 | 55.6 | 9.64 | 5.92 | 55.7 | 9.64 | 5.93 | 55.9 | 9.64 | 5.95 | 56.0 | 9.64 | 5.96 | 56.2 | 9.64 | 5.98 | 56.3 | 9.64 | 5.99 | 56.5 | 9.64 | 6.01 |
| 10.90 | 55.2 | 9.65 | 5.87 | 55.3 | 9.65 | 5.88 | 55.5 | 9.65 | 5.90 | 55.6 | 9.65 | 5.91 | 55.8 | 9.65 | 5.92 | 55.9 | 9.65 | 5.94 | 56.1 | 9.65 | 5.95 | 56.2 | 9.65 | 5.97 | 56.3 | 9.65 | 5.98 | 56.5 | 9.65 | 6.00 |
| 11.00 | 55.2 | 9.66 | 5.86 | 55.3 | 9.66 | 5.87 | 55.5 | 9.66 | 5.89 | 55.6 | 9.66 | 5.90 | 55.8 | 9.66 | 5.91 | 55.9 | 9.66 | 5.93 | 56.1 | 9.66 | 5.94 | 56.2 | 9.66 | 5.96 | 56.4 | 9.66 | 5.97 | 56.5 | 9.66 | 5.99 |
| 11.10 | 55.2 | 9.67 | 5.85 | 55.4 | 9.67 | 5.86 | 55.5 | 9.67 | 5.88 | 55.6 | 9.67 | 5.89 | 55.8 | 9.67 | 5.91 | 55.9 | 9.67 | 5.92 | 56.1 | 9.67 | 5.93 | 56.2 | 9.67 | 5.95 | 56.4 | 9.67 | 5.96 | 56.5 | 9.67 | 5.98 |
| 11.20 | 55.2 | 9.68 | 5.84 | 55.4 | 9.68 | 5.85 | 55.5 | 9.68 | 5.87 | 55.7 | 9.68 | 5.88 | 55.8 | 9.68 | 5.90 | 55.9 | 9.68 | 5.91 | 56.1 | 9.68 | 5.92 | 56.2 | 9.68 | 5.94 | 56.4 | 9.68 | 5.95 | 56.5 | 9.68 | 5.97 |
| 11.30 | 55.2 | 9.70 | 5.83 | 55.4 | 9.70 | 5.84 | 55.5 | 9.70 | 5.86 | 55.7 | 9.70 | 5.87 | 55.8 | 9.70 | 5.89 | 56.0 | 9.70 | 5.90 | 56.1 | 9.70 | 5.92 | 56.3 | 9.70 | 5.93 | 56.4 | 9.70 | 5.94 | 56.5 | 9.70 | 5.96 |
| 11.40 | 55.2 | 9.71 | 5.82 | 55.4 | 9.71 | 5.83 | 55.5 | 9.71 | 5.85 | 55.7 | 9.71 | 5.86 | 55.8 | 9.71 | 5.88 | 56.0 | 9.71 | 5.89 | 56.1 | 9.71 | 5.91 | 56.3 | 9.71 | 5.92 | 56.4 | 9.71 | 5.93 | 56.6 | 9.71 | 5.95 |
| 11.50 | 55.3 | 9.72 | 5.81 | 55.4 | 9.72 | 5.82 | 55.6 | 9.72 | 5.84 | 55.7 | 9.72 | 5.85 | 55.8 | 9.72 | 5.87 | 56.0 | 9.72 | 5.88 | 56.1 | 9.72 | 5.90 | 56.3 | 9.72 | 5.91 | 56.4 | 9.72 | 5.93 | 56.6 | 9.72 | 5.94 |
| 11.60 | 55.3 | 9.73 | 5.80 | 55.4 | 9.73 | 5.81 | 55.6 | 9.73 | 5.83 | 55.7 | 9.73 | 5.84 | 55.9 | 9.73 | 5.86 | 56.0 | 9.73 | 5.87 | 56.1 | 9.73 | 5.89 | 56.3 | 9.73 | 5.90 | 56.4 | 9.73 | 5.92 | 56.6 | 9.73 | 5.93 |
| 11.70 | 55.3 | 9.74 | 5.79 | 55.4 | 9.74 | 5.80 | 55.6 | 9.74 | 5.82 | 55.7 | 9.74 | 5.83 | 55.9 | 9.74 | 5.85 | 56.0 | 9.74 | 5.86 | 56.2 | 9.74 | 5.88 | 56.3 | 9.74 | 5.89 | 56.5 | 9.74 | 5.91 | 56.6 | 9.74 | 5.92 |
| 11.80 | 55.3 | 9.75 | 5.78 | 55.4 | 9.75 | 5.79 | 55.6 | 9.75 | 5.81 | 55.7 | 9.75 | 5.82 | 55.9 | 9.75 | 5.84 | 56.0 | 9.75 | 5.85 | 56.2 | 9.75 | 5.87 | 56.3 | 9.75 | 5.88 | 56.5 | 9.75 | 5.90 | 56.6 | 9.75 | 5.91 |
| 11.90 | 55.3 | 9.76 | 5.77 | 55.5 | 9.76 | 5.78 | 55.6 | 9.76 | 5.80 | 55.8 | 9.76 | 5.81 | 55.9 | 9.76 | 5.83 | 56.0 | 9.76 | 5.84 | 56.2 | 9.76 | 5.86 | 56.3 | 9.76 | 5.87 | 56.5 | 9.76 | 5.89 | 56.6 | 9.76 | 5.90 |
| 12.00 | 55.3 | 9.77 | 5.76 | 55.5 | 9.77 | 5.77 | 55.6 | 9.77 | 5.79 | 55.8 | 9.77 | 5.80 | 55.9 | 9.77 | 5.82 | 56.1 | 9.77 | 5.83 | 56.2 | 9.77 | 5.85 | 56.4 | 9.77 | 5.86 | 56.5 | 9.77 | 5.88 | 56.6 | 9.77 | 5.89 |
| 12.10 | 55.3 | 9.78 | 5.75 | 55.5 | 9.78 | 5.76 | 55.6 | 9.78 | 5.78 | 55.8 | 9.78 | 5.79 | 55.9 | 9.78 | 5.81 | 56.1 | 9.78 | 5.82 | 56.2 | 9.78 | 5.84 | 56.4 | 9.78 | 5.85 | 56.5 | 9.78 | 5.87 | 56.7 | 9.78 | 5.88 |
| 12.30 | 55.4 | 9.81 | 5.73 | 55.5 | 9.81 | 5.75 | 55.7 | 9.81 | 5.76 | 55.8 | 9.81 | 5.77 | 56.0 | 9.81 | 5.79 | 56.1 | 9.81 | 5.80 | 56.2 | 9.81 | 5.82 | 56.4 | 9.81 | 5.83 | 56.5 | 9.81 | 5.85 | 56.7 | 9.81 | 5.86 |
| 12.30 | 55.4 | 9.81 | 5.73 | 55.5 | 9.81 | 5.75 | 55.7 | 9.81 | 5.76 | 55.8 | 9.81 | 5.77 | 56.0 | 9.81 | 5.79 | 56.1 | 9.81 | 5.80 | 56.2 | 9.81 | 5.82 | 56.4 | 9.81 | 5.83 | 56.5 | 9.81 | 5.85 | 56.7 | 9.81 | 5.86 |
| 12.40 | 55.4 | 9.82 | 5.72 | 55.5 | 9.82 | 5.74 | 55.7 | 9.82 | 5.75 | 55.8 | 9.82 | 5.76 | 56.0 | 9.82 | 5.78 | 56.1 | 9.82 | 5.79 | 56.3 | 9.82 | 5.81 | 56.4 | 9.82 | 5.82 | 56.6 | 9.82 | 5.84 | 56.7 | 9.82 | 5.85 |
| 12.50 | 55.4 | 9.83 | 5.71 | 55.5 | 9.83 | 5.73 | 55.7 | 9.83 | 5.74 | 55.8 | 9.83 | 5.76 | 56.0 | 9.83 | 5.77 | 56.1 | 9.83 | 5.78 | 56.3 | 9.83 | 5.80 | 56.4 | 9.83 | 5.81 | 56.6 | 9.83 | 5.83 | 56.7 | 9.83 | 5.84 |
| 12.60 | 55.4 | 9.84 | 5.70 | 55.6 | 9.84 | 5.72 | 55.7 | 9.84 | 5.73 | 55.9 | 9.84 | 5.75 | 56.0 | 9.84 | 5.76 | 56.1 | 9.84 | 5.77 | 56.3 | 9.84 | 5.79 | 56.4 | 9.84 | 5.80 | 56.6 | 9.84 | 5.82 | 56.7 | 9.84 | 5.83 |
| 12.70 | 55.4 | 9.85 | 5.69 | 55.6 | 9.85 | 5.71 | 55.7 | 9.85 | 5.72 | 55.9 | 9.85 | 5.74 | 56.0 | 9.85 | 5.75 | 56.2 | 9.85 | 5.76 | 56.3 | 9.85 | 5.78 | 56.5 | 9.85 | 5.79 | 56.6 | 9.85 | 5.81 | 56.8 | 9.85 | 5.82 |
| 12.80 | 55.4 | 9.86 | 5.68 | 55.6 | 9.86 | 5.70 | 55.7 | 9.86 | 5.71 | 55.9 | 9.86 | 5.73 | 56.0 | 9.86 | 5.74 | 56.2 | 9.86 | 5.76 | 56.3 | 9.86 | 5.77 | 56.5 | 9.86 | 5.78 | 56.6 | 9.86 | 5.80 | 56.8 | 9.86 | 5.81 |
| 12.90 | 55.4 | 9.87 | 5.67 | 55.6 | 9.87 | 5.69 | 55.7 | 9.87 | 5.70 | 55.9 | 9.87 | 5.72 | 56.0 | 9.87 | 5.73 | 56.2 | 9.87 | 5.75 | 56.3 | 9.87 | 5.76 | 56.5 | 9.87 | 5.77 | 56.6 | 9.87 | 5.79 | 56.8 | 9.87 | 5.80 |
| 13.00 | 55.5 | 9.89 | 5.66 | 55.6 | 9.89 | 5.68 | 55.8 | 9.89 | 5.69 | 55.9 | 9.89 | 5.71 | 56.1 | 9.89 | 5.72 | 56.2 | 9.89 | 5.74 | 56.4 | 9.89 | 5.75 | 56.5 | 9.89 | 5.76 | 56.6 | 9.89 | 5.78 | 56.8 | 9.89 | 5.79 |
| 13.10 | 55.5 | 9.90 | 5.65 | 55.6 | 9.90 | 5.67 | 55.8 | 9.90 | 5.68 | 55.9 | 9.90 | 5.70 | 56.1 | 9.90 | 5.71 | 56.2 | 9.90 | 5.73 | 56.4 | 9.90 | 5.74 | 56.5 | 9.90 | 5.76 | 56.7 | 9.90 | 5.77 | 56.8 | 9.90 | 5.78 |
| 13.20 | 55.5 | 9.91 | 5.64 | 55.6 | 9.91 | 5.66 | 55.8 | 9.91 | 5.67 | 55.9 | 9.91 | 5.69 | 56.1 | 9.91 | 5.70 | 56.2 | 9.91 | 5.72 | 56.4 | 9.91 | 5.73 | 56.5 | 9.91 | 5.75 | 56.7 | 9.91 | 5.76 | 56.8 | 9.91 | 5.77 |
| 13.30 | 55.5 | 9.92 | 5.63 | 55.7 | 9.92 | 5.65 | 55.8 | 9.92 | 5.66 | 55.9 | 9.92 | 5.68 | 56.1 | 9.92 | 5.69 | 56.2 | 9.92 | 5.71 | 56.4 | 9.92 | 5.72 | 56.5 | 9.92 | 5.74 | 56.7 | 9.92 | 5.75 | 56.8 | 9.92 | 5.76 |
| 13.40 | 55.5 | 9.93 | 5.62 | 55.7 | 9.93 | 5.64 | 55.8 | 9.93 | 5.65 | 56.0 | 9.93 | 5.67 | 56.1 | 9.93 | 5.68 | 56.3 | 9.93 | 5.70 | 56.4 | 9.93 | 5.71 | 56.6 | 9.93 | 5.73 | 56.7 | 9.93 | 5.74 | 56.9 | 9.93 | 5.76 |
| 13.50 | 55.5 | 9.94 | 5.61 | 55.7 | 9.94 | 5.63 | 55.8 | 9.94 | 5.64 | 56.0 | 9.94 | 5.66 | 56.1 | 9.94 | 5.67 | 56.3 | 9.94 | 5.69 | 56.4 | 9.94 | 5.70 | 56.6 | 9.94 | 5.72 | 56.7 | 9.94 | 5.73 | 56.9 | 9.94 | 5.75 |
| 13.60 | 55.5 | 9.95 | 5.60 | 55.7 | 9.95 | 5.62 | 55.8 | 9.95 | 5.63 | 56.0 | 9.95 | 5.65 | 56.1 | 9.95 | 5.66 | 56.3 | 9.95 | 5.68 | 56.4 | 9.95 | 5.69 | 56.6 | 9.95 | 5.71 | 56.7 | 9.95 | 5.72 | 56.9 | 9.95 | 5.74 |
| 13.70 | 55.6 | 9.97 | 5.59 | 55.7 | 9.97 | 5.61 | 55.9 | 9.97 | 5.62 | 56.0 | 9.97 | 5.64 | 56.2 | 9.97 | 5.65 | 56.3 | 9.97 | 5.67 | 56.5 | 9.97 | 5.68 | 56.6 | 9.97 | 5.70 | 56.8 | 9.97 | 5.71 | 56.9 | 9.97 | 5.73 |
| 13.80 | 55.6 | 9.98 | 5.58 | 55.7 | 9.98 | 5.60 | 55.9 | 9.98 | 5.61 | 56.0 | 9.98 | 5.63 | 56.2 | 9.98 | 5.64 | 56.3 | 9.98 | 5.66 | 56.5 | 9.98 | 5.67 | 56.6 | 9.98 | 5.69 | 56.8 | 9.98 | 5.70 | 56.9 | 9.98 | 5.72 |
| 13.90 | 55.6 | 9.99 | 5.57 | 55.7 | 9.99 | 5.59 | 55.9 | 9.99 | 5.60 | 56.0 | 9.99 | 5.62 | 56.2 | 9.99 | 5.63 | 56.3 | 9.99 | 5.65 | 56.5 | 9.99 | 5.66 | 56.6 | 9.99 | 5.68 | 56.8 | 9.99 | 5.69 | 56.9 | 9.99 | 5.71 |
| 14.00 | 55.6 | 10.00 | 5.56 | 55.8 | 10.00 | 5.58 | 55.9 | 10.00 | 5.59 | 56.1 | 10.00 | 5.61 | 56.2 | 10.00 | 5.62 | 56.4 | 10.00 | 5.64 | 56.5 | 10.00 | 5.65 | 56.7 | 10.00 | 5.67 | 56.8 | 10.00 | 5.68 | 57.0 | 10.00 | 5.70 |
| 14.10 | 55.6 | 10.01 | 5.55 | 55.8 | 10.01 | 5.56 | 55.9 | 10.01 | 5.58 | 56.1 | 10.01 | 5.59 | 56.2 | 10.01 | 5.61 | 56.4 | 10.01 | 5.62 | 56.5 | 10.01 | 5.64 | 56.7 | 10.01 | 5.65 | 56.8 | 10.01 | 5.67 | 57.0 | 10.01 | 5.68 |
| 14.20 | 55.6 | 10.02 | 5.54 | 55.8 | 10.02 | 5.55 | 55.9 | 10.02 | 5.57 | 56.1 | 10.02 | 5.58 | 56.2 | 10.02 | 5.60 | 56.4 | 10.02 | 5.61 | 56.5 | 10.02 | 5.63 | 56.7 | 10.02 | 5.64 | 56.8 | 10.02 | 5.66 | 57.0 | 10.02 | 5.67 |
| 14.30 | 55.6 | 10.04 | 5.53 | 55.8 | 10.04 | 5.54 | 55.9 | 10.04 | 5.56 | 56.1 | 10.04 | 5.57 | 56.2 | 10.04 | 5.59 | 56.4 | 10.04 | 5.60 | 56.5 | 10.04 | 5.62 | 56.7 | 10.04 | 5.63 | 56.8 | 10.04 | 5.65 | 57.0 | 10.04 | 5.66 |
| 14.40 | 55.7 | 10.05 | 5.52 | 55.8 | 10.05 | 5.53 | 56.0 | 10.05 | 5.55 | 56.1 | 10.05 | 5.56 | 56.3 | 10.05 | 5.58 | 56.4 | 10.05 | 5.59 | 56.6 | 10.05 | 5.61 | 56.7 | 10.05 | 5.62 | 56.9 | 10.05 | 5.64 | 57.0 | 10.05 | 5.65 |
| 14.50 | 55.7 | 10.06 | 5.51 | 55.8 | 10.06 | 5.52 | 56.0 | 10.06 | 5.54 | 56.1 | 10.06 | 5.55 | 56.3 | 10.06 | 5.57 | 56.4 | 10.06 | 5.58 | 56.6 | 10.06 | 5.60 | 56.7 | 10.06 | 5.61 | 56.9 | 10.06 | 5.63 | 57.0 | 10.06 | 5.64 |
| 14.60 | 55.7 | 10.07 | 5.50 | 55.8 | 10.07 | 5.51 | 56.0 | 10.07 | 5.53 | 56.1 | 10.07 | 5.54 | 56.3 | 10.07 | 5.56 | 56.4 | 10.07 | 5.57 | 56.6 | 10.07 | 5.59 | 56.7 | 10.07 | 5.60 | 56.9 | 10.07 | 5.62 | 57.0 | 10.07 | 5.63 |
| 14.70 | 55.7 | 10.08 | 5.49 | 55.8 | 10.08 | 5.50 | 56.0 | 10.08 | 5.52 | 56.2 | 10.08 | 5.53 | 56.3 | 10.08 | 5.55 | 56.5 | 10.08 | 5.56 | 56.6 | 10.08 | 5.58 | 56.8 | 10.08 | 5.59 | 56.9 | 10.08 | 5.61 | 57.1 | 10.08 | 5.62 |
| 14.80 | 55.7 | 10.09 | 5.48 | 55.9 | 10.09 | 5.49 | 56.0 | 10.09 | 5.51 | 56.2 | 10.09 | 5.52 | 56.3 | 10.09 | 5.54 | 56.5 | 10.09 | 5.55 | 56.6 | 10.09 | 5.57 | 56.8 | 10.09 | 5.58 | 56.9 | 10.09 | 5.60 | 57.1 | 10.09 | 5.61 |
| 14.90 | 55.7 | 10.11 | 5.47 | 55.9 | 10.11 | 5.48 | 56.0 | 10.11 | 5.50 | 56.2 | 10.11 | 5.51 | 56.3 | 10.11 | 5.53 | 56.5 | 10.11 | 5.54 | 56.6 | 10.11 | 5.56 | 56.8 | 10.11 | 5.57 | 56.9 | 10.11 | 5.59 | 57.1 | 10.11 | 5.60 |
| 15.00 | 55.7 | 10.12 | 5.46 | 55.9 | 10.12 | 5.47 | 56.0 | 10.12 | 5.49 | 56.2 | 10.12 | 5.50 | 56.3 | 10.12 | 5.52 | 56.5 | 10.12 | 5.53 | 56.7 | 10.12 | 5.55 | 56.8 | 10.12 | 5.56 | 57.0 | 10.12 | 5.58 | 57.1 | 10.12 | 5.59 |
| 15.10 | 55.8 | 10.13 | 5.45 | 55.9 | 10.13 | 5.46 | 56.1 | 10.13 | 5.48 | 56.2 | 10.13 | 5.49 | 56.4 | 10.13 | 5.51 | 56.5 | 10.13 | 5.52 | 56.7 | 10.13 | 5.54 | 56.8 | 10.13 | 5.55 | 57.0 | 10.13 | 5.57 | 57.1 | 10.13 | 5.58 |
| 15.20 | 55.8 | 10.14 | 5.44 | 55.9 | 10.14 | 5.45 | 56.1 | 10.14 | 5.47 | 56.2 | 10.14 | 5.48 | 56.4 | 10.14 | 5.50 | 56.5 | 10.14 | 5.51 | 56.7 | 10.14 | 5.53 | 56.8 | 10.14 | 5.54 | 57.0 | 10.14 | 5.56 | 57.1 | 10.14 | 5.57 |
| 15.30 | 55.8 | 10.15 | 5.42 | 55.9 | 10.15 | 5.44 | 56.1 | 10.15 | 5.46 | 56.2 | 10.15 | 5.47 | 56.4 | 10.15 | 5.49 | 56.5 | 10.15 | 5.50 | 56.7 | 10.15 | 5.52 | 56.9 | 10.15 | 5.53 | 57.0 | 10.15 | 5.55 | 57.2 | 10.15 | 5.56 |
| 15.40 | 55.8 | 10.17 | 5.41 | 56.0 | 10.17 | 5.43 | 56.1 | 10.17 | 5.44 | 56.3 | 10.17 | 5.46 | 56.4 | 10.17 | 5.48 | 56.6 | 10.17 | 5.49 | 56.7 | 10.17 | 5.51 | 56.9 | 10.17 | 5.52 | 57.0 | 10.17 | 5.54 | 57.2 | 10.17 | 5.55 |
| 15.50 | 55.8 | 10.18 | 5.40 | 56.0 | 10.18 | 5.42 | 56.1 | 10.18 | 5.43 | 56.3 | 10.18 | 5.45 | 56.4 | 10.18 | 5.46 | 56.6 | 10.18 | 5.48 | 56.7 | 10.18 | 5.50 | 56.9 | 10.18 | 5.51 | 57.0 | 10.18 | 5.53 | 57.2 | 10.18 | 5.54 |
| 15.60 | 55.8 | 10.19 | 5.39 | 56.0 | 10.19 | 5.41 | 56.1 | 10.19 | 5.42 | 56.3 | 10.19 | 5.44 | 56.4 | 10.19 | 5.45 | 56.6 | 10.19 | 5.47 | 56.7 | 10.19 | 5.48 | 56.9 | 10.19 | 5.50 | 57.1 | 10.19 | 5.52 | 57.2 | 10.19 | 5.53 |
| 15.70 | 55.8 | 10.20 | 5.38 | 56.0 | 10.20 | 5.40 | 56.1 | 10.20 | 5.41 | 56.3 | 10.20 | 5.43 | 56.5 | 10.20 | 5.44 | 56.6 | 10.20 | 5.46 | 56.8 | 10.20 | 5.47 | 56.9 | 10.20 | 5.49 | 57.1 | 10.20 | 5.50 | 57.2 | 10.20 | 5.52 |
| 15.80 | 55.9 | 10.21 | 5.37 | 56.0 | 10.21 | 5.39 | 56.2 | 10.21 | 5.40 | 56.3 | 10.21 | 5.42 | 56.5 | 10.21 | 5.43 | 56.6 | 10.21 | 5.45 | 56.8 | 10.21 | 5.46 | 56.9 | 10.21 | 5.48 | 57.1 | 10.21 | 5.49 | 57.2 | 10.21 | 5.51 |
| 15.90 | 55.9 | 10.23 | 5.36 | 56.0 | 10.23 | 5.38 | 56.2 | 10.23 | 5.39 | 56.3 | 10.23 | 5.41 | 56.5 | 10.23 | 5.42 | 56.6 | 10.23 | 5.44 | 56.8 | 10.23 | 5.45 | 56.9 | 10.23 | 5.47 | 57.1 | 10.23 | 5.48 | 57.3 | 10.23 | 5.50 |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 10.0; Water (ml) = (% Absorption x 10.0 / 100) + (10.0 - sample weight)

## 10-gram Mixograph: Absorption, Flour and Water Amount Table
## (9.0 - 9.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 9.00 | | | 9.10 | | | 9.20 | | | 9.30 | | | 9.40 | | | 9.50 | | | 9.60 | | | 9.70 | | | 9.80 | | | 9.90 | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml |
| 9.00 | 56.4 | 9.45 | 6.19 | 56.5 | 9.45 | 6.20 | 56.6 | 9.45 | 6.21 | 56.8 | 9.45 | 6.23 | 56.9 | 9.45 | 6.24 | 57.1 | 9.45 | 6.26 | 57.2 | 9.45 | 6.27 | 57.4 | 9.45 | 6.28 | 57.5 | 9.45 | 6.30 | 57.6 | 9.45 | 6.31 |
| 9.10 | 56.4 | 9.46 | 6.18 | 56.5 | 9.46 | 6.19 | 56.7 | 9.46 | 6.20 | 56.8 | 9.46 | 6.22 | 56.9 | 9.46 | 6.23 | 57.1 | 9.46 | 6.25 | 57.2 | 9.46 | 6.26 | 57.4 | 9.46 | 6.28 | 57.5 | 9.46 | 6.29 | 57.6 | 9.46 | 6.30 |
| 9.20 | 56.4 | 9.47 | 6.17 | 56.5 | 9.47 | 6.18 | 56.7 | 9.47 | 6.20 | 56.8 | 9.47 | 6.21 | 57.0 | 9.47 | 6.22 | 57.1 | 9.47 | 6.24 | 57.2 | 9.47 | 6.25 | 57.4 | 9.47 | 6.27 | 57.5 | 9.47 | 6.28 | 57.7 | 9.47 | 6.30 |
| 9.30 | 56.4 | 9.48 | 6.16 | 56.5 | 9.48 | 6.17 | 56.7 | 9.48 | 6.19 | 56.8 | 9.48 | 6.20 | 57.0 | 9.48 | 6.22 | 57.1 | 9.48 | 6.23 | 57.3 | 9.48 | 6.24 | 57.4 | 9.48 | 6.26 | 57.5 | 9.48 | 6.27 | 57.7 | 9.48 | 6.29 |
| 9.40 | 56.4 | 9.49 | 6.15 | 56.6 | 9.49 | 6.16 | 56.7 | 9.49 | 6.18 | 56.8 | 9.49 | 6.19 | 57.0 | 9.49 | 6.21 | 57.1 | 9.49 | 6.22 | 57.3 | 9.49 | 6.23 | 57.4 | 9.49 | 6.25 | 57.6 | 9.49 | 6.26 | 57.7 | 9.49 | 6.28 |
| 9.50 | 56.4 | 9.50 | 6.14 | 56.6 | 9.50 | 6.15 | 56.7 | 9.50 | 6.17 | 56.9 | 9.50 | 6.18 | 57.0 | 9.50 | 6.20 | 57.1 | 9.50 | 6.21 | 57.3 | 9.50 | 6.23 | 57.4 | 9.50 | 6.24 | 57.6 | 9.50 | 6.25 | 57.7 | 9.50 | 6.27 |
| 9.60 | 56.4 | 9.51 | 6.13 | 56.6 | 9.51 | 6.15 | 56.7 | 9.51 | 6.16 | 56.9 | 9.51 | 6.17 | 57.0 | 9.51 | 6.19 | 57.2 | 9.51 | 6.20 | 57.3 | 9.51 | 6.22 | 57.4 | 9.51 | 6.23 | 57.6 | 9.51 | 6.25 | 57.7 | 9.51 | 6.26 |
| 9.70 | 56.5 | 9.52 | 6.12 | 56.6 | 9.52 | 6.14 | 56.7 | 9.52 | 6.15 | 56.9 | 9.52 | 6.16 | 57.0 | 9.52 | 6.18 | 57.2 | 9.52 | 6.19 | 57.3 | 9.52 | 6.21 | 57.5 | 9.52 | 6.22 | 57.6 | 9.52 | 6.24 | 57.7 | 9.52 | 6.25 |
| 9.80 | 56.5 | 9.53 | 6.11 | 56.6 | 9.53 | 6.13 | 56.8 | 9.53 | 6.14 | 56.9 | 9.53 | 6.16 | 57.0 | 9.53 | 6.17 | 57.2 | 9.53 | 6.18 | 57.3 | 9.53 | 6.20 | 57.5 | 9.53 | 6.21 | 57.6 | 9.53 | 6.23 | 57.8 | 9.53 | 6.24 |
| 9.90 | 56.5 | 9.54 | 6.10 | 56.6 | 9.54 | 6.12 | 56.8 | 9.54 | 6.13 | 56.9 | 9.54 | 6.15 | 57.1 | 9.54 | 6.16 | 57.2 | 9.54 | 6.18 | 57.3 | 9.54 | 6.19 | 57.5 | 9.54 | 6.20 | 57.6 | 9.54 | 6.22 | 57.8 | 9.54 | 6.23 |
| 10.00 | 56.5 | 9.56 | 6.09 | 56.6 | 9.56 | 6.11 | 56.8 | 9.56 | 6.12 | 56.9 | 9.56 | 6.14 | 57.1 | 9.56 | 6.15 | 57.2 | 9.56 | 6.17 | 57.4 | 9.56 | 6.18 | 57.5 | 9.56 | 6.19 | 57.6 | 9.56 | 6.21 | 57.8 | 9.56 | 6.22 |
| 10.10 | 56.5 | 9.57 | 6.09 | 56.7 | 9.57 | 6.10 | 56.8 | 9.57 | 6.11 | 56.9 | 9.57 | 6.13 | 57.1 | 9.57 | 6.14 | 57.2 | 9.57 | 6.16 | 57.4 | 9.57 | 6.17 | 57.5 | 9.57 | 6.19 | 57.7 | 9.57 | 6.20 | 57.8 | 9.57 | 6.21 |
| 10.20 | 56.5 | 9.58 | 6.08 | 56.7 | 9.58 | 6.09 | 56.8 | 9.58 | 6.10 | 57.0 | 9.58 | 6.12 | 57.1 | 9.58 | 6.13 | 57.2 | 9.58 | 6.15 | 57.4 | 9.58 | 6.16 | 57.5 | 9.58 | 6.18 | 57.7 | 9.58 | 6.19 | 57.8 | 9.58 | 6.21 |
| 10.30 | 56.5 | 9.59 | 6.07 | 56.7 | 9.59 | 6.08 | 56.8 | 9.59 | 6.10 | 57.0 | 9.59 | 6.11 | 57.1 | 9.59 | 6.12 | 57.3 | 9.59 | 6.14 | 57.4 | 9.59 | 6.15 | 57.5 | 9.59 | 6.17 | 57.7 | 9.59 | 6.18 | 57.8 | 9.59 | 6.20 |
| 10.40 | 56.6 | 9.60 | 6.06 | 56.7 | 9.60 | 6.07 | 56.8 | 9.60 | 6.09 | 57.0 | 9.60 | 6.10 | 57.1 | 9.60 | 6.12 | 57.3 | 9.60 | 6.13 | 57.4 | 9.60 | 6.14 | 57.6 | 9.60 | 6.16 | 57.7 | 9.60 | 6.17 | 57.9 | 9.60 | 6.19 |
| 10.50 | 56.6 | 9.61 | 6.05 | 56.7 | 9.61 | 6.06 | 56.9 | 9.61 | 6.08 | 57.0 | 9.61 | 6.09 | 57.1 | 9.61 | 6.11 | 57.3 | 9.61 | 6.12 | 57.4 | 9.61 | 6.13 | 57.6 | 9.61 | 6.15 | 57.7 | 9.61 | 6.16 | 57.9 | 9.61 | 6.18 |
| 10.60 | 56.6 | 9.62 | 6.04 | 56.7 | 9.62 | 6.05 | 56.9 | 9.62 | 6.07 | 57.0 | 9.62 | 6.08 | 57.2 | 9.62 | 6.10 | 57.3 | 9.62 | 6.11 | 57.5 | 9.62 | 6.13 | 57.6 | 9.62 | 6.14 | 57.7 | 9.62 | 6.15 | 57.9 | 9.62 | 6.17 |
| 10.70 | 56.6 | 9.63 | 6.03 | 56.7 | 9.63 | 6.04 | 56.9 | 9.63 | 6.06 | 57.0 | 9.63 | 6.07 | 57.2 | 9.63 | 6.09 | 57.3 | 9.63 | 6.10 | 57.5 | 9.63 | 6.12 | 57.6 | 9.63 | 6.13 | 57.8 | 9.63 | 6.15 | 57.9 | 9.63 | 6.16 |
| 10.80 | 56.6 | 9.64 | 6.02 | 56.8 | 9.64 | 6.03 | 56.9 | 9.64 | 6.05 | 57.0 | 9.64 | 6.06 | 57.2 | 9.64 | 6.08 | 57.3 | 9.64 | 6.09 | 57.5 | 9.64 | 6.11 | 57.6 | 9.64 | 6.12 | 57.8 | 9.64 | 6.14 | 57.9 | 9.64 | 6.15 |
| 10.90 | 56.6 | 9.65 | 6.01 | 56.8 | 9.65 | 6.03 | 56.9 | 9.65 | 6.04 | 57.1 | 9.65 | 6.05 | 57.2 | 9.65 | 6.07 | 57.4 | 9.65 | 6.08 | 57.5 | 9.65 | 6.10 | 57.6 | 9.65 | 6.11 | 57.8 | 9.65 | 6.13 | 57.9 | 9.65 | 6.14 |
| 11.00 | 56.6 | 9.66 | 6.00 | 56.8 | 9.66 | 6.02 | 56.9 | 9.66 | 6.03 | 57.1 | 9.66 | 6.05 | 57.2 | 9.66 | 6.06 | 57.4 | 9.66 | 6.07 | 57.5 | 9.66 | 6.09 | 57.7 | 9.66 | 6.10 | 57.8 | 9.66 | 6.12 | 57.9 | 9.66 | 6.13 |
| 11.10 | 56.7 | 9.67 | 5.99 | 56.8 | 9.67 | 6.01 | 56.9 | 9.67 | 6.02 | 57.1 | 9.67 | 6.04 | 57.2 | 9.67 | 6.05 | 57.4 | 9.67 | 6.06 | 57.5 | 9.67 | 6.08 | 57.7 | 9.67 | 6.09 | 57.8 | 9.67 | 6.11 | 58.0 | 9.67 | 6.12 |
| 11.20 | 56.7 | 9.68 | 5.98 | 56.8 | 9.68 | 6.00 | 57.0 | 9.68 | 6.01 | 57.1 | 9.68 | 6.03 | 57.3 | 9.68 | 6.04 | 57.4 | 9.68 | 6.06 | 57.5 | 9.68 | 6.07 | 57.7 | 9.68 | 6.08 | 57.8 | 9.68 | 6.10 | 58.0 | 9.68 | 6.11 |
| 11.30 | 56.7 | 9.70 | 5.97 | 56.8 | 9.70 | 5.99 | 57.0 | 9.70 | 6.00 | 57.1 | 9.70 | 6.02 | 57.3 | 9.70 | 6.03 | 57.4 | 9.70 | 6.05 | 57.6 | 9.70 | 6.06 | 57.7 | 9.70 | 6.08 | 57.9 | 9.70 | 6.09 | 58.0 | 9.70 | 6.10 |
| 11.40 | 56.7 | 9.71 | 5.96 | 56.8 | 9.71 | 5.98 | 57.0 | 9.71 | 5.99 | 57.1 | 9.71 | 6.01 | 57.3 | 9.71 | 6.02 | 57.4 | 9.71 | 6.04 | 57.6 | 9.71 | 6.05 | 57.7 | 9.71 | 6.07 | 57.9 | 9.71 | 6.08 | 58.0 | 9.71 | 6.09 |
| 11.50 | 56.7 | 9.72 | 5.95 | 56.9 | 9.72 | 5.97 | 57.0 | 9.72 | 5.98 | 57.2 | 9.72 | 6.00 | 57.3 | 9.72 | 6.01 | 57.4 | 9.72 | 6.03 | 57.6 | 9.72 | 6.04 | 57.7 | 9.72 | 6.06 | 57.9 | 9.72 | 6.07 | 58.0 | 9.72 | 6.09 |
| 11.60 | 56.7 | 9.73 | 5.94 | 56.9 | 9.73 | 5.96 | 57.0 | 9.73 | 5.97 | 57.2 | 9.73 | 5.99 | 57.3 | 9.73 | 6.00 | 57.5 | 9.73 | 6.02 | 57.6 | 9.73 | 6.03 | 57.8 | 9.73 | 6.05 | 57.9 | 9.73 | 6.06 | 58.0 | 9.73 | 6.08 |
| 11.70 | 56.7 | 9.74 | 5.94 | 56.9 | 9.74 | 5.95 | 57.0 | 9.74 | 5.96 | 57.2 | 9.74 | 5.98 | 57.3 | 9.74 | 5.99 | 57.5 | 9.74 | 6.01 | 57.6 | 9.74 | 6.02 | 57.8 | 9.74 | 6.04 | 57.9 | 9.74 | 6.05 | 58.1 | 9.74 | 6.07 |
| 11.80 | 56.8 | 9.75 | 5.93 | 56.9 | 9.75 | 5.94 | 57.1 | 9.75 | 5.96 | 57.2 | 9.75 | 5.97 | 57.3 | 9.75 | 5.98 | 57.5 | 9.75 | 6.00 | 57.6 | 9.75 | 6.01 | 57.8 | 9.75 | 6.03 | 57.9 | 9.75 | 6.04 | 58.1 | 9.75 | 6.06 |
| 11.90 | 56.8 | 9.76 | 5.92 | 56.9 | 9.76 | 5.93 | 57.1 | 9.76 | 5.95 | 57.2 | 9.76 | 5.96 | 57.4 | 9.76 | 5.97 | 57.5 | 9.76 | 5.99 | 57.7 | 9.76 | 6.00 | 57.8 | 9.76 | 6.02 | 57.9 | 9.76 | 6.03 | 58.1 | 9.76 | 6.05 |
| 12.00 | 56.8 | 9.77 | 5.91 | 56.9 | 9.77 | 5.92 | 57.1 | 9.77 | 5.94 | 57.2 | 9.77 | 5.95 | 57.4 | 9.77 | 5.97 | 57.5 | 9.77 | 5.98 | 57.7 | 9.77 | 5.99 | 57.8 | 9.77 | 6.01 | 58.0 | 9.77 | 6.02 | 58.1 | 9.77 | 6.04 |
| 12.10 | 56.8 | 9.78 | 5.90 | 57.0 | 9.78 | 5.91 | 57.1 | 9.78 | 5.93 | 57.2 | 9.78 | 5.94 | 57.4 | 9.78 | 5.96 | 57.5 | 9.78 | 5.97 | 57.7 | 9.78 | 5.99 | 57.8 | 9.78 | 6.00 | 58.0 | 9.78 | 6.01 | 58.1 | 9.78 | 6.03 |
| 12.30 | 56.8 | 9.81 | 5.88 | 57.0 | 9.81 | 5.89 | 57.1 | 9.81 | 5.91 | 57.3 | 9.81 | 5.92 | 57.4 | 9.81 | 5.94 | 57.6 | 9.81 | 5.95 | 57.7 | 9.81 | 5.97 | 57.9 | 9.81 | 5.98 | 58.0 | 9.81 | 6.00 | 58.2 | 9.81 | 6.01 |
| 12.30 | 56.8 | 9.81 | 5.88 | 57.0 | 9.81 | 5.89 | 57.1 | 9.81 | 5.91 | 57.3 | 9.81 | 5.92 | 57.4 | 9.81 | 5.94 | 57.6 | 9.81 | 5.95 | 57.7 | 9.81 | 5.97 | 57.9 | 9.81 | 5.98 | 58.0 | 9.81 | 6.00 | 58.2 | 9.81 | 6.01 |
| 12.40 | 56.9 | 9.82 | 5.87 | 57.0 | 9.82 | 5.88 | 57.1 | 9.82 | 5.90 | 57.3 | 9.82 | 5.91 | 57.4 | 9.82 | 5.93 | 57.6 | 9.82 | 5.94 | 57.7 | 9.82 | 5.96 | 57.9 | 9.82 | 5.97 | 58.0 | 9.82 | 5.99 | 58.2 | 9.82 | 6.00 |
| 12.50 | 56.9 | 9.83 | 5.86 | 57.0 | 9.83 | 5.87 | 57.2 | 9.83 | 5.89 | 57.3 | 9.83 | 5.90 | 57.5 | 9.83 | 5.92 | 57.6 | 9.83 | 5.93 | 57.8 | 9.83 | 5.95 | 57.9 | 9.83 | 5.96 | 58.0 | 9.83 | 5.98 | 58.2 | 9.83 | 5.99 |
| 12.60 | 56.9 | 9.84 | 5.85 | 57.0 | 9.84 | 5.86 | 57.2 | 9.84 | 5.88 | 57.3 | 9.84 | 5.89 | 57.5 | 9.84 | 5.91 | 57.6 | 9.84 | 5.92 | 57.8 | 9.84 | 5.94 | 57.9 | 9.84 | 5.95 | 58.1 | 9.84 | 5.97 | 58.2 | 9.84 | 5.98 |
| 12.70 | 56.9 | 9.85 | 5.84 | 57.0 | 9.85 | 5.85 | 57.2 | 9.85 | 5.87 | 57.3 | 9.85 | 5.88 | 57.5 | 9.85 | 5.90 | 57.6 | 9.85 | 5.91 | 57.8 | 9.85 | 5.93 | 57.9 | 9.85 | 5.94 | 58.1 | 9.85 | 5.96 | 58.2 | 9.85 | 5.97 |
| 12.80 | 56.9 | 9.86 | 5.83 | 57.1 | 9.86 | 5.84 | 57.2 | 9.86 | 5.86 | 57.4 | 9.86 | 5.87 | 57.5 | 9.86 | 5.89 | 57.7 | 9.86 | 5.90 | 57.8 | 9.86 | 5.92 | 57.9 | 9.86 | 5.93 | 58.1 | 9.86 | 5.95 | 58.2 | 9.86 | 5.96 |
| 12.90 | 56.9 | 9.87 | 5.82 | 57.1 | 9.87 | 5.83 | 57.2 | 9.87 | 5.85 | 57.4 | 9.87 | 5.86 | 57.5 | 9.87 | 5.88 | 57.7 | 9.87 | 5.89 | 57.8 | 9.87 | 5.91 | 58.0 | 9.87 | 5.92 | 58.1 | 9.87 | 5.94 | 58.3 | 9.87 | 5.95 |
| 13.00 | 56.9 | 9.89 | 5.81 | 57.1 | 9.89 | 5.82 | 57.2 | 9.89 | 5.84 | 57.4 | 9.89 | 5.85 | 57.5 | 9.89 | 5.87 | 57.7 | 9.89 | 5.88 | 57.8 | 9.89 | 5.90 | 58.0 | 9.89 | 5.91 | 58.1 | 9.89 | 5.93 | 58.3 | 9.89 | 5.94 |
| 13.10 | 57.0 | 9.90 | 5.80 | 57.1 | 9.90 | 5.81 | 57.3 | 9.90 | 5.83 | 57.4 | 9.90 | 5.84 | 57.6 | 9.90 | 5.86 | 57.7 | 9.90 | 5.87 | 57.9 | 9.90 | 5.89 | 58.0 | 9.90 | 5.90 | 58.1 | 9.90 | 5.92 | 58.3 | 9.90 | 5.93 |
| 13.20 | 57.0 | 9.91 | 5.79 | 57.1 | 9.91 | 5.80 | 57.3 | 9.91 | 5.82 | 57.4 | 9.91 | 5.83 | 57.6 | 9.91 | 5.85 | 57.7 | 9.91 | 5.86 | 57.9 | 9.91 | 5.88 | 58.0 | 9.91 | 5.89 | 58.2 | 9.91 | 5.91 | 58.3 | 9.91 | 5.92 |
| 13.30 | 57.0 | 9.92 | 5.78 | 57.1 | 9.92 | 5.79 | 57.3 | 9.92 | 5.81 | 57.4 | 9.92 | 5.82 | 57.6 | 9.92 | 5.84 | 57.7 | 9.92 | 5.85 | 57.9 | 9.92 | 5.87 | 58.0 | 9.92 | 5.88 | 58.2 | 9.92 | 5.90 | 58.3 | 9.92 | 5.91 |
| 13.40 | 57.0 | 9.93 | 5.77 | 57.2 | 9.93 | 5.78 | 57.3 | 9.93 | 5.80 | 57.5 | 9.93 | 5.81 | 57.6 | 9.93 | 5.83 | 57.8 | 9.93 | 5.84 | 57.9 | 9.93 | 5.86 | 58.0 | 9.93 | 5.87 | 58.2 | 9.93 | 5.89 | 58.3 | 9.93 | 5.90 |
| 13.50 | 57.0 | 9.94 | 5.76 | 57.2 | 9.94 | 5.77 | 57.3 | 9.94 | 5.79 | 57.5 | 9.94 | 5.80 | 57.6 | 9.94 | 5.82 | 57.8 | 9.94 | 5.83 | 57.9 | 9.94 | 5.85 | 58.1 | 9.94 | 5.86 | 58.2 | 9.94 | 5.88 | 58.4 | 9.94 | 5.89 |
| 13.60 | 57.0 | 9.95 | 5.75 | 57.2 | 9.95 | 5.76 | 57.3 | 9.95 | 5.78 | 57.5 | 9.95 | 5.79 | 57.6 | 9.95 | 5.81 | 57.8 | 9.95 | 5.82 | 57.9 | 9.95 | 5.84 | 58.1 | 9.95 | 5.85 | 58.2 | 9.95 | 5.87 | 58.4 | 9.95 | 5.88 |
| 13.70 | 57.1 | 9.97 | 5.74 | 57.2 | 9.97 | 5.76 | 57.4 | 9.97 | 5.77 | 57.5 | 9.97 | 5.78 | 57.7 | 9.97 | 5.80 | 57.8 | 9.97 | 5.81 | 57.9 | 9.97 | 5.83 | 58.1 | 9.97 | 5.84 | 58.2 | 9.97 | 5.86 | 58.4 | 9.97 | 5.87 |
| 13.80 | 57.1 | 9.98 | 5.73 | 57.2 | 9.98 | 5.75 | 57.4 | 9.98 | 5.76 | 57.5 | 9.98 | 5.77 | 57.7 | 9.98 | 5.79 | 57.8 | 9.98 | 5.80 | 58.0 | 9.98 | 5.82 | 58.1 | 9.98 | 5.83 | 58.3 | 9.98 | 5.85 | 58.4 | 9.98 | 5.86 |
| 13.90 | 57.1 | 9.99 | 5.72 | 57.2 | 9.99 | 5.74 | 57.4 | 9.99 | 5.75 | 57.5 | 9.99 | 5.76 | 57.7 | 9.99 | 5.78 | 57.8 | 9.99 | 5.79 | 58.0 | 9.99 | 5.81 | 58.1 | 9.99 | 5.82 | 58.3 | 9.99 | 5.84 | 58.4 | 9.99 | 5.85 |
| 14.00 | 57.1 | 10.00 | 5.71 | 57.3 | 10.00 | 5.73 | 57.4 | 10.00 | 5.74 | 57.6 | 10.00 | 5.76 | 57.7 | 10.00 | 5.77 | 57.9 | 10.00 | 5.79 | 58.0 | 10.00 | 5.80 | 58.2 | 10.00 | 5.82 | 58.3 | 10.00 | 5.83 | 58.5 | 10.00 | 5.85 |
| 14.10 | 57.1 | 10.01 | 5.70 | 57.3 | 10.01 | 5.71 | 57.4 | 10.01 | 5.73 | 57.6 | 10.01 | 5.74 | 57.7 | 10.01 | 5.76 | 57.9 | 10.01 | 5.78 | 58.0 | 10.01 | 5.79 | 58.2 | 10.01 | 5.81 | 58.3 | 10.01 | 5.82 | 58.5 | 10.01 | 5.84 |
| 14.20 | 57.1 | 10.02 | 5.69 | 57.3 | 10.02 | 5.70 | 57.4 | 10.02 | 5.72 | 57.6 | 10.02 | 5.73 | 57.7 | 10.02 | 5.75 | 57.9 | 10.02 | 5.77 | 58.0 | 10.02 | 5.78 | 58.2 | 10.02 | 5.80 | 58.3 | 10.02 | 5.81 | 58.5 | 10.02 | 5.83 |
| 14.30 | 57.1 | 10.04 | 5.68 | 57.3 | 10.04 | 5.69 | 57.4 | 10.04 | 5.71 | 57.6 | 10.04 | 5.72 | 57.7 | 10.04 | 5.74 | 57.9 | 10.04 | 5.75 | 58.1 | 10.04 | 5.77 | 58.2 | 10.04 | 5.79 | 58.4 | 10.04 | 5.80 | 58.5 | 10.04 | 5.82 |
| 14.40 | 57.2 | 10.05 | 5.67 | 57.3 | 10.05 | 5.68 | 57.5 | 10.05 | 5.70 | 57.6 | 10.05 | 5.71 | 57.8 | 10.05 | 5.73 | 57.9 | 10.05 | 5.74 | 58.1 | 10.05 | 5.76 | 58.2 | 10.05 | 5.78 | 58.4 | 10.05 | 5.79 | 58.5 | 10.05 | 5.81 |
| 14.50 | 57.2 | 10.06 | 5.66 | 57.3 | 10.06 | 5.67 | 57.5 | 10.06 | 5.69 | 57.6 | 10.06 | 5.70 | 57.8 | 10.06 | 5.72 | 57.9 | 10.06 | 5.73 | 58.1 | 10.06 | 5.75 | 58.2 | 10.06 | 5.77 | 58.4 | 10.06 | 5.78 | 58.5 | 10.06 | 5.80 |
| 14.60 | 57.2 | 10.07 | 5.65 | 57.3 | 10.07 | 5.66 | 57.5 | 10.07 | 5.68 | 57.6 | 10.07 | 5.69 | 57.8 | 10.07 | 5.71 | 58.0 | 10.07 | 5.72 | 58.1 | 10.07 | 5.74 | 58.3 | 10.07 | 5.75 | 58.4 | 10.07 | 5.77 | 58.6 | 10.07 | 5.79 |
| 14.70 | 57.2 | 10.08 | 5.64 | 57.4 | 10.08 | 5.65 | 57.5 | 10.08 | 5.67 | 57.7 | 10.08 | 5.68 | 57.8 | 10.08 | 5.70 | 58.0 | 10.08 | 5.71 | 58.1 | 10.08 | 5.73 | 58.3 | 10.08 | 5.74 | 58.4 | 10.08 | 5.76 | 58.6 | 10.08 | 5.78 |
| 14.80 | 57.2 | 10.09 | 5.63 | 57.4 | 10.09 | 5.64 | 57.5 | 10.09 | 5.66 | 57.7 | 10.09 | 5.67 | 57.8 | 10.09 | 5.69 | 58.0 | 10.09 | 5.70 | 58.1 | 10.09 | 5.72 | 58.3 | 10.09 | 5.73 | 58.4 | 10.09 | 5.75 | 58.6 | 10.09 | 5.77 |
| 14.90 | 57.2 | 10.11 | 5.62 | 57.4 | 10.11 | 5.63 | 57.5 | 10.11 | 5.65 | 57.7 | 10.11 | 5.66 | 57.8 | 10.11 | 5.68 | 58.0 | 10.11 | 5.69 | 58.2 | 10.11 | 5.71 | 58.3 | 10.11 | 5.72 | 58.5 | 10.11 | 5.74 | 58.6 | 10.11 | 5.75 |
| 15.00 | 57.3 | 10.12 | 5.61 | 57.4 | 10.12 | 5.62 | 57.6 | 10.12 | 5.64 | 57.7 | 10.12 | 5.65 | 57.9 | 10.12 | 5.67 | 58.0 | 10.12 | 5.68 | 58.2 | 10.12 | 5.70 | 58.3 | 10.12 | 5.71 | 58.5 | 10.12 | 5.73 | 58.6 | 10.12 | 5.74 |
| 15.10 | 57.3 | 10.13 | 5.60 | 57.4 | 10.13 | 5.61 | 57.6 | 10.13 | 5.63 | 57.7 | 10.13 | 5.64 | 57.9 | 10.13 | 5.66 | 58.0 | 10.13 | 5.67 | 58.2 | 10.13 | 5.69 | 58.3 | 10.13 | 5.70 | 58.5 | 10.13 | 5.72 | 58.6 | 10.13 | 5.73 |
| 15.20 | 57.3 | 10.14 | 5.59 | 57.4 | 10.14 | 5.60 | 57.6 | 10.14 | 5.62 | 57.7 | 10.14 | 5.63 | 57.9 | 10.14 | 5.65 | 58.1 | 10.14 | 5.66 | 58.2 | 10.14 | 5.68 | 58.4 | 10.14 | 5.69 | 58.5 | 10.14 | 5.71 | 58.7 | 10.14 | 5.72 |
| 15.30 | 57.3 | 10.15 | 5.58 | 57.5 | 10.15 | 5.59 | 57.6 | 10.15 | 5.61 | 57.8 | 10.15 | 5.62 | 57.9 | 10.15 | 5.64 | 58.1 | 10.15 | 5.65 | 58.2 | 10.15 | 5.67 | 58.4 | 10.15 | 5.68 | 58.5 | 10.15 | 5.70 | 58.7 | 10.15 | 5.71 |
| 15.40 | 57.3 | 10.17 | 5.57 | 57.5 | 10.17 | 5.58 | 57.6 | 10.17 | 5.60 | 57.8 | 10.17 | 5.61 | 57.9 | 10.17 | 5.63 | 58.1 | 10.17 | 5.64 | 58.2 | 10.17 | 5.66 | 58.4 | 10.17 | 5.67 | 58.5 | 10.17 | 5.69 | 58.7 | 10.17 | 5.70 |
| 15.50 | 57.3 | 10.18 | 5.56 | 57.5 | 10.18 | 5.57 | 57.6 | 10.18 | 5.59 | 57.8 | 10.18 | 5.60 | 58.0 | 10.18 | 5.62 | 58.1 | 10.18 | 5.63 | 58.3 | 10.18 | 5.65 | 58.4 | 10.18 | 5.66 | 58.6 | 10.18 | 5.68 | 58.7 | 10.18 | 5.69 |
| 15.60 | 57.4 | 10.19 | 5.55 | 57.5 | 10.19 | 5.56 | 57.7 | 10.19 | 5.58 | 57.8 | 10.19 | 5.59 | 58.0 | 10.19 | 5.61 | 58.1 | 10.19 | 5.62 | 58.3 | 10.19 | 5.64 | 58.4 | 10.19 | 5.65 | 58.6 | 10.19 | 5.67 | 58.7 | 10.19 | 5.68 |
| 15.70 | 57.4 | 10.20 | 5.54 | 57.5 | 10.20 | 5.55 | 57.7 | 10.20 | 5.57 | 57.8 | 10.20 | 5.58 | 58.0 | 10.20 | 5.60 | 58.1 | 10.20 | 5.61 | 58.3 | 10.20 | 5.63 | 58.4 | 10.20 | 5.64 | 58.6 | 10.20 | 5.66 | 58.7 | 10.20 | 5.67 |
| 15.80 | 57.4 | 10.21 | 5.53 | 57.5 | 10.21 | 5.54 | 57.7 | 10.21 | 5.56 | 57.8 | 10.21 | 5.57 | 58.0 | 10.21 | 5.59 | 58.2 | 10.21 | 5.60 | 58.3 | 10.21 | 5.62 | 58.5 | 10.21 | 5.63 | 58.6 | 10.21 | 5.65 | 58.8 | 10.21 | 5.66 |
| 15.90 | 57.4 | 10.23 | 5.51 | 57.6 | 10.23 | 5.53 | 57.7 | 10.23 | 5.55 | 57.9 | 10.23 | 5.56 | 58.0 | 10.23 | 5.58 | 58.2 | 10.23 | 5.59 | 58.3 | 10.23 | 5.61 | 58.5 | 10.23 | 5.62 | 58.6 | 10.23 | 5.64 | 58.8 | 10.23 | 5.65 |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 10.0; Water (ml) = (% Absorption x 10.0 / 100) + (10.0 - sample weight)

## 10-gram Mixograph: Absorption, Flour and Water Amount Table
## (10.0 - 10.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 10.00 | | | 10.10 | | | 10.20 | | | 10.30 | | | 10.40 | | | 10.50 | | | 10.60 | | | 10.70 | | | 10.80 | | | 10.90 | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml |
| 9.00 | 57.8 | 9.45 | 6.33 | 57.9 | 9.45 | 6.34 | 58.1 | 9.45 | 6.36 | 58.2 | 9.45 | 6.37 | 58.3 | 9.45 | 6.38 | 58.5 | 9.45 | 6.40 | 58.6 | 9.45 | 6.41 | 58.8 | 9.45 | 6.43 | 58.9 | 9.45 | 6.44 | 59.1 | 9.45 | 6.45 |
| 9.10 | 57.8 | 9.46 | 6.32 | 57.9 | 9.46 | 6.33 | 58.1 | 9.46 | 6.35 | 58.2 | 9.46 | 6.36 | 58.4 | 9.46 | 6.37 | 58.5 | 9.46 | 6.39 | 58.6 | 9.46 | 6.40 | 58.8 | 9.46 | 6.42 | 58.9 | 9.46 | 6.43 | 59.1 | 9.46 | 6.45 |
| 9.20 | 57.8 | 9.47 | 6.31 | 57.9 | 9.47 | 6.32 | 58.1 | 9.47 | 6.34 | 58.2 | 9.47 | 6.35 | 58.4 | 9.47 | 6.37 | 58.5 | 9.47 | 6.38 | 58.7 | 9.47 | 6.39 | 58.8 | 9.47 | 6.41 | 58.9 | 9.47 | 6.42 | 59.1 | 9.47 | 6.44 |
| 9.30 | 57.8 | 9.48 | 6.30 | 58.0 | 9.48 | 6.31 | 58.1 | 9.48 | 6.33 | 58.2 | 9.48 | 6.34 | 58.4 | 9.48 | 6.36 | 58.5 | 9.48 | 6.37 | 58.7 | 9.48 | 6.39 | 58.8 | 9.48 | 6.40 | 59.0 | 9.48 | 6.41 | 59.1 | 9.48 | 6.43 |
| 9.40 | 57.8 | 9.49 | 6.29 | 58.0 | 9.49 | 6.31 | 58.1 | 9.49 | 6.32 | 58.3 | 9.49 | 6.33 | 58.4 | 9.49 | 6.35 | 58.6 | 9.49 | 6.36 | 58.7 | 9.49 | 6.38 | 58.8 | 9.49 | 6.39 | 59.0 | 9.49 | 6.41 | 59.1 | 9.49 | 6.42 |
| 9.50 | 57.9 | 9.50 | 6.28 | 58.0 | 9.50 | 6.30 | 58.1 | 9.50 | 6.31 | 58.3 | 9.50 | 6.33 | 58.4 | 9.50 | 6.34 | 58.6 | 9.50 | 6.35 | 58.7 | 9.50 | 6.37 | 58.9 | 9.50 | 6.38 | 59.0 | 9.50 | 6.40 | 59.1 | 9.50 | 6.41 |
| 9.60 | 57.9 | 9.51 | 6.27 | 58.0 | 9.51 | 6.29 | 58.2 | 9.51 | 6.30 | 58.3 | 9.51 | 6.32 | 58.4 | 9.51 | 6.33 | 58.6 | 9.51 | 6.35 | 58.7 | 9.51 | 6.36 | 58.9 | 9.51 | 6.37 | 59.0 | 9.51 | 6.39 | 59.2 | 9.51 | 6.40 |
| 9.70 | 57.9 | 9.52 | 6.26 | 58.0 | 9.52 | 6.28 | 58.2 | 9.52 | 6.29 | 58.3 | 9.52 | 6.31 | 58.5 | 9.52 | 6.32 | 58.6 | 9.52 | 6.34 | 58.7 | 9.52 | 6.35 | 58.9 | 9.52 | 6.36 | 59.0 | 9.52 | 6.38 | 59.2 | 9.52 | 6.39 |
| 9.80 | 57.9 | 9.53 | 6.26 | 58.0 | 9.53 | 6.27 | 58.2 | 9.53 | 6.28 | 58.3 | 9.53 | 6.30 | 58.5 | 9.53 | 6.31 | 58.6 | 9.53 | 6.33 | 58.8 | 9.53 | 6.34 | 58.9 | 9.53 | 6.36 | 59.0 | 9.53 | 6.37 | 59.2 | 9.53 | 6.38 |
| 9.90 | 57.9 | 9.54 | 6.25 | 58.1 | 9.54 | 6.26 | 58.2 | 9.54 | 6.28 | 58.3 | 9.54 | 6.29 | 58.5 | 9.54 | 6.30 | 58.6 | 9.54 | 6.32 | 58.8 | 9.54 | 6.33 | 58.9 | 9.54 | 6.35 | 59.1 | 9.54 | 6.36 | 59.2 | 9.54 | 6.38 |
| 10.00 | 57.9 | 9.56 | 6.24 | 58.1 | 9.56 | 6.25 | 58.2 | 9.56 | 6.27 | 58.4 | 9.56 | 6.28 | 58.5 | 9.56 | 6.30 | 58.7 | 9.56 | 6.31 | 58.8 | 9.56 | 6.32 | 58.9 | 9.56 | 6.34 | 59.1 | 9.56 | 6.35 | 59.2 | 9.56 | 6.37 |
| 10.10 | 57.9 | 9.57 | 6.23 | 58.1 | 9.57 | 6.24 | 58.2 | 9.57 | 6.26 | 58.4 | 9.57 | 6.27 | 58.5 | 9.57 | 6.29 | 58.7 | 9.57 | 6.30 | 58.8 | 9.57 | 6.31 | 59.0 | 9.57 | 6.33 | 59.1 | 9.57 | 6.34 | 59.2 | 9.57 | 6.36 |
| 10.20 | 58.0 | 9.58 | 6.22 | 58.1 | 9.58 | 6.23 | 58.3 | 9.58 | 6.25 | 58.4 | 9.58 | 6.26 | 58.5 | 9.58 | 6.28 | 58.7 | 9.58 | 6.29 | 58.8 | 9.58 | 6.31 | 59.0 | 9.58 | 6.32 | 59.1 | 9.58 | 6.33 | 59.3 | 9.58 | 6.35 |
| 10.30 | 58.0 | 9.59 | 6.21 | 58.1 | 9.59 | 6.22 | 58.3 | 9.59 | 6.24 | 58.4 | 9.59 | 6.25 | 58.6 | 9.59 | 6.27 | 58.7 | 9.59 | 6.28 | 58.8 | 9.59 | 6.30 | 59.0 | 9.59 | 6.31 | 59.1 | 9.59 | 6.33 | 59.3 | 9.59 | 6.34 |
| 10.40 | 58.0 | 9.60 | 6.20 | 58.1 | 9.60 | 6.22 | 58.3 | 9.60 | 6.23 | 58.4 | 9.60 | 6.24 | 58.6 | 9.60 | 6.26 | 58.7 | 9.60 | 6.27 | 58.9 | 9.60 | 6.29 | 59.0 | 9.60 | 6.30 | 59.1 | 9.60 | 6.32 | 59.3 | 9.60 | 6.33 |
| 10.50 | 58.0 | 9.61 | 6.19 | 58.2 | 9.61 | 6.21 | 58.3 | 9.61 | 6.22 | 58.4 | 9.61 | 6.24 | 58.6 | 9.61 | 6.25 | 58.7 | 9.61 | 6.26 | 58.9 | 9.61 | 6.28 | 59.0 | 9.61 | 6.29 | 59.2 | 9.61 | 6.31 | 59.3 | 9.61 | 6.32 |
| 10.60 | 58.0 | 9.62 | 6.18 | 58.2 | 9.62 | 6.20 | 58.3 | 9.62 | 6.21 | 58.5 | 9.62 | 6.23 | 58.6 | 9.62 | 6.24 | 58.8 | 9.62 | 6.26 | 58.9 | 9.62 | 6.27 | 59.0 | 9.62 | 6.28 | 59.2 | 9.62 | 6.30 | 59.3 | 9.62 | 6.31 |
| 10.70 | 58.0 | 9.63 | 6.17 | 58.2 | 9.63 | 6.19 | 58.3 | 9.63 | 6.20 | 58.5 | 9.63 | 6.22 | 58.6 | 9.63 | 6.23 | 58.8 | 9.63 | 6.25 | 58.9 | 9.63 | 6.26 | 59.1 | 9.63 | 6.28 | 59.2 | 9.63 | 6.29 | 59.3 | 9.63 | 6.30 |
| 10.80 | 58.1 | 9.64 | 6.16 | 58.2 | 9.64 | 6.18 | 58.4 | 9.64 | 6.19 | 58.5 | 9.64 | 6.21 | 58.6 | 9.64 | 6.22 | 58.8 | 9.64 | 6.24 | 58.9 | 9.64 | 6.25 | 59.1 | 9.64 | 6.27 | 59.2 | 9.64 | 6.28 | 59.4 | 9.64 | 6.30 |
| 10.90 | 58.1 | 9.65 | 6.16 | 58.2 | 9.65 | 6.17 | 58.4 | 9.65 | 6.18 | 58.5 | 9.65 | 6.20 | 58.7 | 9.65 | 6.21 | 58.8 | 9.65 | 6.23 | 58.9 | 9.65 | 6.24 | 59.1 | 9.65 | 6.26 | 59.2 | 9.65 | 6.27 | 59.4 | 9.65 | 6.29 |
| 11.00 | 58.1 | 9.66 | 6.15 | 58.2 | 9.66 | 6.16 | 58.4 | 9.66 | 6.18 | 58.5 | 9.66 | 6.19 | 58.7 | 9.66 | 6.20 | 58.8 | 9.66 | 6.22 | 59.0 | 9.66 | 6.23 | 59.1 | 9.66 | 6.25 | 59.3 | 9.66 | 6.26 | 59.4 | 9.66 | 6.28 |
| 11.10 | 58.1 | 9.67 | 6.14 | 58.3 | 9.67 | 6.15 | 58.4 | 9.67 | 6.17 | 58.5 | 9.67 | 6.18 | 58.7 | 9.67 | 6.20 | 58.8 | 9.67 | 6.21 | 59.0 | 9.67 | 6.22 | 59.1 | 9.67 | 6.24 | 59.3 | 9.67 | 6.25 | 59.4 | 9.67 | 6.27 |
| 11.20 | 58.1 | 9.68 | 6.13 | 58.3 | 9.68 | 6.14 | 58.4 | 9.68 | 6.16 | 58.6 | 9.68 | 6.17 | 58.7 | 9.68 | 6.19 | 58.9 | 9.68 | 6.20 | 59.0 | 9.68 | 6.22 | 59.1 | 9.68 | 6.23 | 59.3 | 9.68 | 6.24 | 59.4 | 9.68 | 6.26 |
| 11.30 | 58.1 | 9.70 | 6.12 | 58.3 | 9.70 | 6.13 | 58.4 | 9.70 | 6.15 | 58.6 | 9.70 | 6.16 | 58.7 | 9.70 | 6.18 | 58.9 | 9.70 | 6.19 | 59.0 | 9.70 | 6.21 | 59.2 | 9.70 | 6.22 | 59.3 | 9.70 | 6.24 | 59.5 | 9.70 | 6.25 |
| 11.40 | 58.2 | 9.71 | 6.11 | 58.3 | 9.71 | 6.12 | 58.5 | 9.71 | 6.14 | 58.6 | 9.71 | 6.15 | 58.7 | 9.71 | 6.17 | 58.9 | 9.71 | 6.18 | 59.0 | 9.71 | 6.20 | 59.2 | 9.71 | 6.21 | 59.3 | 9.71 | 6.23 | 59.5 | 9.71 | 6.24 |
| 11.50 | 58.2 | 9.72 | 6.10 | 58.3 | 9.72 | 6.11 | 58.5 | 9.72 | 6.13 | 58.6 | 9.72 | 6.14 | 58.8 | 9.72 | 6.16 | 58.9 | 9.72 | 6.17 | 59.1 | 9.72 | 6.19 | 59.2 | 9.72 | 6.20 | 59.3 | 9.72 | 6.22 | 59.5 | 9.72 | 6.23 |
| 11.60 | 58.2 | 9.73 | 6.09 | 58.3 | 9.73 | 6.11 | 58.5 | 9.73 | 6.12 | 58.6 | 9.73 | 6.13 | 58.8 | 9.73 | 6.15 | 58.9 | 9.73 | 6.16 | 59.1 | 9.73 | 6.18 | 59.2 | 9.73 | 6.19 | 59.4 | 9.73 | 6.21 | 59.5 | 9.73 | 6.22 |
| 11.70 | 58.2 | 9.74 | 6.08 | 58.4 | 9.74 | 6.10 | 58.5 | 9.74 | 6.11 | 58.6 | 9.74 | 6.13 | 58.8 | 9.74 | 6.14 | 58.9 | 9.74 | 6.15 | 59.1 | 9.74 | 6.17 | 59.2 | 9.74 | 6.18 | 59.4 | 9.74 | 6.20 | 59.5 | 9.74 | 6.21 |
| 11.80 | 58.2 | 9.75 | 6.07 | 58.4 | 9.75 | 6.09 | 58.5 | 9.75 | 6.10 | 58.7 | 9.75 | 6.12 | 58.8 | 9.75 | 6.13 | 59.0 | 9.75 | 6.15 | 59.1 | 9.75 | 6.16 | 59.2 | 9.75 | 6.17 | 59.4 | 9.75 | 6.19 | 59.5 | 9.75 | 6.20 |
| 11.90 | 58.2 | 9.76 | 6.06 | 58.4 | 9.76 | 6.08 | 58.5 | 9.76 | 6.09 | 58.7 | 9.76 | 6.11 | 58.8 | 9.76 | 6.12 | 59.0 | 9.76 | 6.14 | 59.1 | 9.76 | 6.15 | 59.3 | 9.76 | 6.17 | 59.4 | 9.76 | 6.18 | 59.6 | 9.76 | 6.19 |
| 12.00 | 58.3 | 9.77 | 6.05 | 58.4 | 9.77 | 6.07 | 58.6 | 9.77 | 6.08 | 58.7 | 9.77 | 6.10 | 58.8 | 9.77 | 6.11 | 59.0 | 9.77 | 6.13 | 59.1 | 9.77 | 6.14 | 59.3 | 9.77 | 6.16 | 59.4 | 9.77 | 6.17 | 59.6 | 9.77 | 6.19 |
| 12.10 | 58.3 | 9.78 | 6.04 | 58.4 | 9.78 | 6.06 | 58.6 | 9.78 | 6.07 | 58.7 | 9.78 | 6.09 | 58.9 | 9.78 | 6.10 | 59.0 | 9.78 | 6.12 | 59.2 | 9.78 | 6.13 | 59.3 | 9.78 | 6.15 | 59.4 | 9.78 | 6.16 | 59.6 | 9.78 | 6.18 |
| 12.30 | 58.3 | 9.81 | 6.02 | 58.5 | 9.81 | 6.04 | 58.6 | 9.81 | 6.05 | 58.8 | 9.81 | 6.07 | 58.9 | 9.81 | 6.08 | 59.0 | 9.81 | 6.10 | 59.2 | 9.81 | 6.11 | 59.3 | 9.81 | 6.13 | 59.5 | 9.81 | 6.14 | 59.6 | 9.81 | 6.16 |
| 12.30 | 58.3 | 9.81 | 6.02 | 58.5 | 9.81 | 6.04 | 58.6 | 9.81 | 6.05 | 58.8 | 9.81 | 6.07 | 58.9 | 9.81 | 6.08 | 59.0 | 9.81 | 6.10 | 59.2 | 9.81 | 6.11 | 59.3 | 9.81 | 6.13 | 59.5 | 9.81 | 6.14 | 59.6 | 9.81 | 6.16 |
| 12.40 | 58.3 | 9.82 | 6.02 | 58.5 | 9.82 | 6.03 | 58.6 | 9.82 | 6.04 | 58.8 | 9.82 | 6.06 | 58.9 | 9.82 | 6.07 | 59.1 | 9.82 | 6.09 | 59.2 | 9.82 | 6.10 | 59.4 | 9.82 | 6.12 | 59.5 | 9.82 | 6.13 | 59.7 | 9.82 | 6.15 |
| 12.50 | 58.3 | 9.83 | 6.01 | 58.5 | 9.83 | 6.02 | 58.6 | 9.83 | 6.04 | 58.8 | 9.83 | 6.05 | 58.9 | 9.83 | 6.06 | 59.1 | 9.83 | 6.08 | 59.2 | 9.83 | 6.09 | 59.4 | 9.83 | 6.11 | 59.5 | 9.83 | 6.12 | 59.7 | 9.83 | 6.14 |
| 12.60 | 58.4 | 9.84 | 6.00 | 58.5 | 9.84 | 6.01 | 58.7 | 9.84 | 6.03 | 58.8 | 9.84 | 6.04 | 59.0 | 9.84 | 6.06 | 59.1 | 9.84 | 6.07 | 59.2 | 9.84 | 6.08 | 59.4 | 9.84 | 6.10 | 59.5 | 9.84 | 6.11 | 59.7 | 9.84 | 6.13 |
| 12.70 | 58.4 | 9.85 | 5.99 | 58.5 | 9.85 | 6.00 | 58.7 | 9.85 | 6.02 | 58.8 | 9.85 | 6.03 | 59.0 | 9.85 | 6.05 | 59.1 | 9.85 | 6.06 | 59.3 | 9.85 | 6.08 | 59.4 | 9.85 | 6.09 | 59.6 | 9.85 | 6.10 | 59.7 | 9.85 | 6.12 |
| 12.80 | 58.4 | 9.86 | 5.98 | 58.5 | 9.86 | 5.99 | 58.7 | 9.86 | 6.01 | 58.8 | 9.86 | 6.02 | 59.0 | 9.86 | 6.04 | 59.1 | 9.86 | 6.05 | 59.3 | 9.86 | 6.07 | 59.4 | 9.86 | 6.08 | 59.6 | 9.86 | 6.10 | 59.7 | 9.86 | 6.11 |
| 12.90 | 58.4 | 9.87 | 5.97 | 58.6 | 9.87 | 5.98 | 58.7 | 9.87 | 6.00 | 58.9 | 9.87 | 6.01 | 59.0 | 9.87 | 6.03 | 59.2 | 9.87 | 6.04 | 59.3 | 9.87 | 6.06 | 59.4 | 9.87 | 6.07 | 59.6 | 9.87 | 6.09 | 59.7 | 9.87 | 6.10 |
| 13.00 | 58.4 | 9.89 | 5.96 | 58.6 | 9.89 | 5.97 | 58.7 | 9.89 | 5.99 | 58.9 | 9.89 | 6.00 | 59.0 | 9.89 | 6.02 | 59.2 | 9.89 | 6.03 | 59.3 | 9.89 | 6.05 | 59.5 | 9.89 | 6.06 | 59.6 | 9.89 | 6.08 | 59.8 | 9.89 | 6.09 |
| 13.10 | 58.4 | 9.90 | 5.95 | 58.6 | 9.90 | 5.96 | 58.7 | 9.90 | 5.98 | 58.9 | 9.90 | 5.99 | 59.0 | 9.90 | 6.01 | 59.2 | 9.90 | 6.02 | 59.3 | 9.90 | 6.04 | 59.5 | 9.90 | 6.05 | 59.6 | 9.90 | 6.07 | 59.8 | 9.90 | 6.08 |
| 13.20 | 58.5 | 9.91 | 5.94 | 58.6 | 9.91 | 5.95 | 58.8 | 9.91 | 5.97 | 58.9 | 9.91 | 5.98 | 59.1 | 9.91 | 6.00 | 59.2 | 9.91 | 6.01 | 59.4 | 9.91 | 6.03 | 59.5 | 9.91 | 6.04 | 59.7 | 9.91 | 6.06 | 59.8 | 9.91 | 6.07 |
| 13.30 | 58.5 | 9.92 | 5.93 | 58.6 | 9.92 | 5.94 | 58.8 | 9.92 | 5.96 | 58.9 | 9.92 | 5.97 | 59.1 | 9.92 | 5.99 | 59.2 | 9.92 | 6.00 | 59.4 | 9.92 | 6.02 | 59.5 | 9.92 | 6.03 | 59.7 | 9.92 | 6.05 | 59.8 | 9.92 | 6.06 |
| 13.40 | 58.5 | 9.93 | 5.92 | 58.6 | 9.93 | 5.93 | 58.8 | 9.93 | 5.95 | 58.9 | 9.93 | 5.96 | 59.1 | 9.93 | 5.98 | 59.2 | 9.93 | 5.99 | 59.4 | 9.93 | 6.01 | 59.5 | 9.93 | 6.02 | 59.7 | 9.93 | 6.04 | 59.8 | 9.93 | 6.05 |
| 13.50 | 58.5 | 9.94 | 5.91 | 58.7 | 9.94 | 5.92 | 58.8 | 9.94 | 5.94 | 59.0 | 9.94 | 5.95 | 59.1 | 9.94 | 5.97 | 59.3 | 9.94 | 5.98 | 59.4 | 9.94 | 6.00 | 59.6 | 9.94 | 6.01 | 59.7 | 9.94 | 6.03 | 59.9 | 9.94 | 6.04 |
| 13.60 | 58.5 | 9.95 | 5.90 | 58.7 | 9.95 | 5.91 | 58.8 | 9.95 | 5.93 | 59.0 | 9.95 | 5.94 | 59.1 | 9.95 | 5.96 | 59.3 | 9.95 | 5.97 | 59.4 | 9.95 | 5.99 | 59.6 | 9.95 | 6.00 | 59.7 | 9.95 | 6.02 | 59.9 | 9.95 | 6.03 |
| 13.70 | 58.5 | 9.97 | 5.89 | 58.7 | 9.97 | 5.90 | 58.8 | 9.97 | 5.92 | 59.0 | 9.97 | 5.93 | 59.1 | 9.97 | 5.95 | 59.3 | 9.97 | 5.96 | 59.4 | 9.97 | 5.98 | 59.6 | 9.97 | 5.99 | 59.7 | 9.97 | 6.01 | 59.9 | 9.97 | 6.02 |
| 13.80 | 58.6 | 9.98 | 5.88 | 58.7 | 9.98 | 5.89 | 58.9 | 9.98 | 5.91 | 59.0 | 9.98 | 5.92 | 59.2 | 9.98 | 5.94 | 59.3 | 9.98 | 5.95 | 59.5 | 9.98 | 5.97 | 59.6 | 9.98 | 5.98 | 59.8 | 9.98 | 6.00 | 59.9 | 9.98 | 6.01 |
| 13.90 | 58.6 | 9.99 | 5.87 | 58.7 | 9.99 | 5.88 | 58.9 | 9.99 | 5.90 | 59.0 | 9.99 | 5.91 | 59.2 | 9.99 | 5.93 | 59.3 | 9.99 | 5.94 | 59.5 | 9.99 | 5.96 | 59.6 | 9.99 | 5.97 | 59.8 | 9.99 | 5.99 | 59.9 | 9.99 | 6.00 |
| 14.00 | 58.6 | 10.00 | 5.86 | 58.8 | 10.00 | 5.88 | 58.9 | 10.00 | 5.89 | 59.1 | 10.00 | 5.91 | 59.2 | 10.00 | 5.92 | 59.4 | 10.00 | 5.94 | 59.5 | 10.00 | 5.95 | 59.7 | 10.00 | 5.97 | 59.8 | 10.00 | 5.98 | 60.0 | 10.00 | 6.00 |
| 14.10 | 58.6 | 10.01 | 5.85 | 58.8 | 10.01 | 5.87 | 58.9 | 10.01 | 5.88 | 59.1 | 10.01 | 5.90 | 59.2 | 10.01 | 5.91 | 59.4 | 10.01 | 5.93 | 59.5 | 10.01 | 5.94 | 59.7 | 10.01 | 5.96 | 59.8 | 10.01 | 5.97 | 60.0 | 10.01 | 5.99 |
| 14.20 | 58.6 | 10.02 | 5.84 | 58.8 | 10.02 | 5.86 | 58.9 | 10.02 | 5.87 | 59.1 | 10.02 | 5.89 | 59.2 | 10.02 | 5.90 | 59.4 | 10.02 | 5.92 | 59.5 | 10.02 | 5.93 | 59.7 | 10.02 | 5.95 | 59.8 | 10.02 | 5.96 | 60.0 | 10.02 | 5.98 |
| 14.30 | 58.7 | 10.04 | 5.83 | 58.8 | 10.04 | 5.85 | 59.0 | 10.04 | 5.86 | 59.1 | 10.04 | 5.88 | 59.3 | 10.04 | 5.89 | 59.4 | 10.04 | 5.91 | 59.6 | 10.04 | 5.92 | 59.7 | 10.04 | 5.94 | 59.9 | 10.04 | 5.95 | 60.0 | 10.04 | 5.97 |
| 14.40 | 58.7 | 10.05 | 5.82 | 58.8 | 10.05 | 5.84 | 59.0 | 10.05 | 5.85 | 59.1 | 10.05 | 5.87 | 59.3 | 10.05 | 5.88 | 59.4 | 10.05 | 5.90 | 59.6 | 10.05 | 5.91 | 59.7 | 10.05 | 5.93 | 59.9 | 10.05 | 5.94 | 60.0 | 10.05 | 5.96 |
| 14.50 | 58.7 | 10.06 | 5.81 | 58.8 | 10.06 | 5.83 | 59.0 | 10.06 | 5.84 | 59.1 | 10.06 | 5.86 | 59.3 | 10.06 | 5.87 | 59.4 | 10.06 | 5.89 | 59.6 | 10.06 | 5.90 | 59.7 | 10.06 | 5.92 | 59.9 | 10.06 | 5.93 | 60.0 | 10.06 | 5.95 |
| 14.60 | 58.7 | 10.07 | 5.80 | 58.9 | 10.07 | 5.82 | 59.0 | 10.07 | 5.83 | 59.2 | 10.07 | 5.85 | 59.3 | 10.07 | 5.86 | 59.5 | 10.07 | 5.88 | 59.6 | 10.07 | 5.89 | 59.8 | 10.07 | 5.91 | 59.9 | 10.07 | 5.92 | 60.1 | 10.07 | 5.94 |
| 14.70 | 58.7 | 10.08 | 5.79 | 58.9 | 10.08 | 5.81 | 59.0 | 10.08 | 5.82 | 59.2 | 10.08 | 5.84 | 59.3 | 10.08 | 5.85 | 59.5 | 10.08 | 5.87 | 59.6 | 10.08 | 5.88 | 59.8 | 10.08 | 5.90 | 59.9 | 10.08 | 5.91 | 60.1 | 10.08 | 5.93 |
| 14.80 | 58.7 | 10.09 | 5.78 | 58.9 | 10.09 | 5.80 | 59.0 | 10.09 | 5.81 | 59.2 | 10.09 | 5.83 | 59.3 | 10.09 | 5.84 | 59.5 | 10.09 | 5.86 | 59.6 | 10.09 | 5.87 | 59.8 | 10.09 | 5.89 | 60.0 | 10.09 | 5.90 | 60.1 | 10.09 | 5.92 |
| 14.90 | 58.8 | 10.11 | 5.77 | 58.9 | 10.11 | 5.79 | 59.1 | 10.11 | 5.80 | 59.2 | 10.11 | 5.82 | 59.4 | 10.11 | 5.83 | 59.5 | 10.11 | 5.85 | 59.7 | 10.11 | 5.86 | 59.8 | 10.11 | 5.88 | 60.0 | 10.11 | 5.89 | 60.1 | 10.11 | 5.91 |
| 15.00 | 58.8 | 10.12 | 5.76 | 58.9 | 10.12 | 5.78 | 59.1 | 10.12 | 5.79 | 59.2 | 10.12 | 5.81 | 59.4 | 10.12 | 5.82 | 59.5 | 10.12 | 5.84 | 59.7 | 10.12 | 5.85 | 59.8 | 10.12 | 5.87 | 60.0 | 10.12 | 5.88 | 60.1 | 10.12 | 5.90 |
| 15.10 | 58.8 | 10.13 | 5.75 | 58.9 | 10.13 | 5.77 | 59.1 | 10.13 | 5.78 | 59.3 | 10.13 | 5.80 | 59.4 | 10.13 | 5.81 | 59.6 | 10.13 | 5.83 | 59.7 | 10.13 | 5.84 | 59.9 | 10.13 | 5.86 | 60.0 | 10.13 | 5.87 | 60.2 | 10.13 | 5.89 |
| 15.20 | 58.8 | 10.14 | 5.74 | 59.0 | 10.14 | 5.75 | 59.1 | 10.14 | 5.77 | 59.3 | 10.14 | 5.79 | 59.4 | 10.14 | 5.80 | 59.6 | 10.14 | 5.82 | 59.7 | 10.14 | 5.83 | 59.9 | 10.14 | 5.85 | 60.0 | 10.14 | 5.86 | 60.2 | 10.14 | 5.88 |
| 15.30 | 58.8 | 10.15 | 5.73 | 59.0 | 10.15 | 5.74 | 59.1 | 10.15 | 5.76 | 59.3 | 10.15 | 5.78 | 59.4 | 10.15 | 5.79 | 59.6 | 10.15 | 5.81 | 59.7 | 10.15 | 5.82 | 59.9 | 10.15 | 5.84 | 60.0 | 10.15 | 5.85 | 60.2 | 10.15 | 5.87 |
| 15.40 | 58.8 | 10.17 | 5.72 | 59.0 | 10.17 | 5.73 | 59.2 | 10.17 | 5.75 | 59.3 | 10.17 | 5.77 | 59.5 | 10.17 | 5.78 | 59.6 | 10.17 | 5.80 | 59.8 | 10.17 | 5.81 | 59.9 | 10.17 | 5.83 | 60.1 | 10.17 | 5.84 | 60.2 | 10.17 | 5.86 |
| 15.50 | 58.9 | 10.18 | 5.71 | 59.0 | 10.18 | 5.72 | 59.2 | 10.18 | 5.74 | 59.3 | 10.18 | 5.75 | 59.5 | 10.18 | 5.77 | 59.6 | 10.18 | 5.79 | 59.8 | 10.18 | 5.80 | 59.9 | 10.18 | 5.82 | 60.1 | 10.18 | 5.83 | 60.2 | 10.18 | 5.85 |
| 15.60 | 58.9 | 10.19 | 5.70 | 59.0 | 10.19 | 5.71 | 59.2 | 10.19 | 5.73 | 59.3 | 10.19 | 5.74 | 59.5 | 10.19 | 5.76 | 59.6 | 10.19 | 5.78 | 59.8 | 10.19 | 5.79 | 60.0 | 10.19 | 5.81 | 60.1 | 10.19 | 5.82 | 60.3 | 10.19 | 5.84 |
| 15.70 | 58.9 | 10.20 | 5.69 | 59.1 | 10.20 | 5.70 | 59.2 | 10.20 | 5.72 | 59.4 | 10.20 | 5.73 | 59.5 | 10.20 | 5.75 | 59.7 | 10.20 | 5.77 | 59.8 | 10.20 | 5.78 | 60.0 | 10.20 | 5.80 | 60.1 | 10.20 | 5.81 | 60.3 | 10.20 | 5.83 |
| 15.80 | 58.9 | 10.21 | 5.68 | 59.1 | 10.21 | 5.69 | 59.2 | 10.21 | 5.71 | 59.4 | 10.21 | 5.72 | 59.5 | 10.21 | 5.74 | 59.7 | 10.21 | 5.75 | 59.8 | 10.21 | 5.77 | 60.0 | 10.21 | 5.79 | 60.1 | 10.21 | 5.80 | 60.3 | 10.21 | 5.82 |
| 15.90 | 58.9 | 10.23 | 5.67 | 59.1 | 10.23 | 5.68 | 59.2 | 10.23 | 5.70 | 59.4 | 10.23 | 5.71 | 59.6 | 10.23 | 5.73 | 59.7 | 10.23 | 5.74 | 59.9 | 10.23 | 5.76 | 60.0 | 10.23 | 5.78 | 60.2 | 10.23 | 5.79 | 60.3 | 10.23 | 5.81 |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 10.0; Water (ml) = (% Absorption x 10.0 / 100) + (10.0 - sample weight)

## 10-gram Mixograph: Absorption, Flour and Water Amount Table
## (11.0 - 11.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 11.00 | | | 11.10 | | | 11.20 | | | 11.30 | | | 11.40 | | | 11.50 | | | 11.60 | | | 11.70 | | | 11.80 | | | 11.90 | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml |
| 9.00 | 59.2 | 9.45 | 6.47 | 59.3 | 9.45 | 6.48 | 59.5 | 9.45 | 6.50 | 59.6 | 9.45 | 6.51 | 59.8 | 9.45 | 6.53 | 59.9 | 9.45 | 6.54 | 60.0 | 9.45 | 6.55 | 60.2 | 9.45 | 6.57 | 60.3 | 9.45 | 6.58 | 60.5 | 9.45 | 6.60 |
| 9.10 | 59.2 | 9.46 | 6.46 | 59.4 | 9.46 | 6.47 | 59.5 | 9.46 | 6.49 | 59.6 | 9.46 | 6.50 | 59.8 | 9.46 | 6.52 | 59.9 | 9.46 | 6.53 | 60.1 | 9.46 | 6.55 | 60.2 | 9.46 | 6.56 | 60.3 | 9.46 | 6.57 | 60.5 | 9.46 | 6.59 |
| 9.20 | 59.2 | 9.47 | 6.45 | 59.4 | 9.47 | 6.47 | 59.5 | 9.47 | 6.48 | 59.7 | 9.47 | 6.49 | 59.8 | 9.47 | 6.51 | 59.9 | 9.47 | 6.52 | 60.1 | 9.47 | 6.54 | 60.2 | 9.47 | 6.55 | 60.4 | 9.47 | 6.57 | 60.5 | 9.47 | 6.58 |
| 9.30 | 59.2 | 9.48 | 6.44 | 59.4 | 9.48 | 6.46 | 59.5 | 9.48 | 6.47 | 59.7 | 9.48 | 6.49 | 59.8 | 9.48 | 6.50 | 60.0 | 9.48 | 6.51 | 60.1 | 9.48 | 6.53 | 60.2 | 9.48 | 6.54 | 60.4 | 9.48 | 6.56 | 60.5 | 9.48 | 6.57 |
| 9.40 | 59.3 | 9.49 | 6.43 | 59.4 | 9.49 | 6.45 | 59.5 | 9.49 | 6.46 | 59.7 | 9.49 | 6.48 | 59.8 | 9.49 | 6.49 | 60.0 | 9.49 | 6.51 | 60.1 | 9.49 | 6.52 | 60.3 | 9.49 | 6.53 | 60.4 | 9.49 | 6.55 | 60.5 | 9.49 | 6.56 |
| 9.50 | 59.3 | 9.50 | 6.43 | 59.4 | 9.50 | 6.44 | 59.6 | 9.50 | 6.45 | 59.7 | 9.50 | 6.47 | 59.8 | 9.50 | 6.48 | 60.0 | 9.50 | 6.50 | 60.1 | 9.50 | 6.51 | 60.3 | 9.50 | 6.52 | 60.4 | 9.50 | 6.54 | 60.6 | 9.50 | 6.55 |
| 9.60 | 59.3 | 9.51 | 6.42 | 59.4 | 9.51 | 6.43 | 59.6 | 9.51 | 6.44 | 59.7 | 9.51 | 6.46 | 59.9 | 9.51 | 6.47 | 60.0 | 9.51 | 6.49 | 60.2 | 9.51 | 6.50 | 60.3 | 9.51 | 6.52 | 60.4 | 9.51 | 6.53 | 60.6 | 9.51 | 6.54 |
| 9.70 | 59.3 | 9.52 | 6.41 | 59.5 | 9.52 | 6.42 | 59.6 | 9.52 | 6.44 | 59.7 | 9.52 | 6.45 | 59.9 | 9.52 | 6.46 | 60.0 | 9.52 | 6.48 | 60.2 | 9.52 | 6.49 | 60.3 | 9.52 | 6.51 | 60.5 | 9.52 | 6.52 | 60.6 | 9.52 | 6.54 |
| 9.80 | 59.3 | 9.53 | 6.40 | 59.5 | 9.53 | 6.41 | 59.6 | 9.53 | 6.43 | 59.8 | 9.53 | 6.44 | 59.9 | 9.53 | 6.46 | 60.0 | 9.53 | 6.47 | 60.2 | 9.53 | 6.48 | 60.3 | 9.53 | 6.50 | 60.5 | 9.53 | 6.51 | 60.6 | 9.53 | 6.53 |
| 9.90 | 59.3 | 9.54 | 6.39 | 59.5 | 9.54 | 6.40 | 59.6 | 9.54 | 6.42 | 59.8 | 9.54 | 6.43 | 59.9 | 9.54 | 6.45 | 60.1 | 9.54 | 6.46 | 60.2 | 9.54 | 6.48 | 60.4 | 9.54 | 6.49 | 60.5 | 9.54 | 6.50 | 60.6 | 9.54 | 6.52 |
| 10.00 | 59.4 | 9.56 | 6.38 | 59.5 | 9.56 | 6.40 | 59.7 | 9.56 | 6.41 | 59.8 | 9.56 | 6.42 | 59.9 | 9.56 | 6.44 | 60.1 | 9.56 | 6.45 | 60.2 | 9.56 | 6.47 | 60.4 | 9.56 | 6.48 | 60.5 | 9.56 | 6.50 | 60.7 | 9.56 | 6.51 |
| 10.10 | 59.4 | 9.57 | 6.37 | 59.5 | 9.57 | 6.39 | 59.7 | 9.57 | 6.40 | 59.8 | 9.57 | 6.42 | 60.0 | 9.57 | 6.43 | 60.1 | 9.57 | 6.44 | 60.2 | 9.57 | 6.46 | 60.4 | 9.57 | 6.47 | 60.5 | 9.57 | 6.49 | 60.7 | 9.57 | 6.50 |
| 10.20 | 59.4 | 9.58 | 6.36 | 59.5 | 9.58 | 6.38 | 59.7 | 9.58 | 6.39 | 59.8 | 9.58 | 6.41 | 60.0 | 9.58 | 6.42 | 60.1 | 9.58 | 6.44 | 60.3 | 9.58 | 6.45 | 60.4 | 9.58 | 6.46 | 60.6 | 9.58 | 6.48 | 60.7 | 9.58 | 6.49 |
| 10.30 | 59.4 | 9.59 | 6.35 | 59.6 | 9.59 | 6.37 | 59.7 | 9.59 | 6.38 | 59.9 | 9.59 | 6.40 | 60.0 | 9.59 | 6.41 | 60.1 | 9.59 | 6.43 | 60.3 | 9.59 | 6.44 | 60.4 | 9.59 | 6.46 | 60.6 | 9.59 | 6.47 | 60.7 | 9.59 | 6.48 |
| 10.40 | 59.4 | 9.60 | 6.35 | 59.6 | 9.60 | 6.36 | 59.7 | 9.60 | 6.37 | 59.9 | 9.60 | 6.39 | 60.0 | 9.60 | 6.40 | 60.2 | 9.60 | 6.42 | 60.3 | 9.60 | 6.43 | 60.4 | 9.60 | 6.45 | 60.6 | 9.60 | 6.46 | 60.7 | 9.60 | 6.48 |
| 10.50 | 59.5 | 9.61 | 6.34 | 59.6 | 9.61 | 6.35 | 59.7 | 9.61 | 6.37 | 59.9 | 9.61 | 6.38 | 60.0 | 9.61 | 6.39 | 60.2 | 9.61 | 6.41 | 60.3 | 9.61 | 6.42 | 60.5 | 9.61 | 6.44 | 60.6 | 9.61 | 6.45 | 60.8 | 9.61 | 6.47 |
| 10.60 | 59.5 | 9.62 | 6.33 | 59.6 | 9.62 | 6.34 | 59.8 | 9.62 | 6.36 | 59.9 | 9.62 | 6.37 | 60.0 | 9.62 | 6.39 | 60.2 | 9.62 | 6.40 | 60.3 | 9.62 | 6.41 | 60.5 | 9.62 | 6.43 | 60.6 | 9.62 | 6.44 | 60.8 | 9.62 | 6.46 |
| 10.70 | 59.5 | 9.63 | 6.32 | 59.6 | 9.63 | 6.33 | 59.8 | 9.63 | 6.35 | 59.9 | 9.63 | 6.36 | 60.1 | 9.63 | 6.38 | 60.2 | 9.63 | 6.39 | 60.4 | 9.63 | 6.41 | 60.5 | 9.63 | 6.42 | 60.6 | 9.63 | 6.43 | 60.8 | 9.63 | 6.45 |
| 10.80 | 59.5 | 9.64 | 6.31 | 59.7 | 9.64 | 6.32 | 59.8 | 9.64 | 6.34 | 59.9 | 9.64 | 6.35 | 60.1 | 9.64 | 6.37 | 60.2 | 9.64 | 6.38 | 60.4 | 9.64 | 6.40 | 60.5 | 9.64 | 6.41 | 60.7 | 9.64 | 6.43 | 60.8 | 9.64 | 6.44 |
| 10.90 | 59.5 | 9.65 | 6.30 | 59.7 | 9.65 | 6.31 | 59.8 | 9.65 | 6.33 | 60.0 | 9.65 | 6.34 | 60.1 | 9.65 | 6.36 | 60.2 | 9.65 | 6.37 | 60.4 | 9.65 | 6.39 | 60.5 | 9.65 | 6.40 | 60.7 | 9.65 | 6.42 | 60.8 | 9.65 | 6.43 |
| 11.00 | 59.5 | 9.66 | 6.29 | 59.7 | 9.66 | 6.31 | 59.8 | 9.66 | 6.32 | 60.0 | 9.66 | 6.33 | 60.1 | 9.66 | 6.35 | 60.3 | 9.66 | 6.36 | 60.4 | 9.66 | 6.38 | 60.6 | 9.66 | 6.39 | 60.7 | 9.66 | 6.41 | 60.8 | 9.66 | 6.42 |
| 11.10 | 59.6 | 9.67 | 6.28 | 59.7 | 9.67 | 6.30 | 59.9 | 9.67 | 6.31 | 60.0 | 9.67 | 6.33 | 60.1 | 9.67 | 6.34 | 60.3 | 9.67 | 6.35 | 60.4 | 9.67 | 6.37 | 60.6 | 9.67 | 6.38 | 60.7 | 9.67 | 6.40 | 60.9 | 9.67 | 6.41 |
| 11.20 | 59.6 | 9.68 | 6.27 | 59.7 | 9.68 | 6.29 | 59.9 | 9.68 | 6.30 | 60.0 | 9.68 | 6.32 | 60.2 | 9.68 | 6.33 | 60.3 | 9.68 | 6.35 | 60.5 | 9.68 | 6.36 | 60.6 | 9.68 | 6.37 | 60.7 | 9.68 | 6.39 | 60.9 | 9.68 | 6.40 |
| 11.30 | 59.6 | 9.70 | 6.26 | 59.7 | 9.70 | 6.28 | 59.9 | 9.70 | 6.29 | 60.0 | 9.70 | 6.31 | 60.2 | 9.70 | 6.32 | 60.3 | 9.70 | 6.34 | 60.5 | 9.70 | 6.35 | 60.6 | 9.70 | 6.37 | 60.8 | 9.70 | 6.38 | 60.9 | 9.70 | 6.40 |
| 11.40 | 59.6 | 9.71 | 6.26 | 59.8 | 9.71 | 6.27 | 59.9 | 9.71 | 6.28 | 60.1 | 9.71 | 6.30 | 60.2 | 9.71 | 6.31 | 60.3 | 9.71 | 6.33 | 60.5 | 9.71 | 6.34 | 60.6 | 9.71 | 6.36 | 60.8 | 9.71 | 6.37 | 60.9 | 9.71 | 6.39 |
| 11.50 | 59.6 | 9.72 | 6.25 | 59.8 | 9.72 | 6.26 | 59.9 | 9.72 | 6.28 | 60.1 | 9.72 | 6.29 | 60.2 | 9.72 | 6.30 | 60.4 | 9.72 | 6.32 | 60.5 | 9.72 | 6.33 | 60.7 | 9.72 | 6.35 | 60.8 | 9.72 | 6.36 | 60.9 | 9.72 | 6.38 |
| 11.60 | 59.7 | 9.73 | 6.24 | 59.8 | 9.73 | 6.25 | 59.9 | 9.73 | 6.27 | 60.1 | 9.73 | 6.28 | 60.2 | 9.73 | 6.30 | 60.4 | 9.73 | 6.31 | 60.5 | 9.73 | 6.32 | 60.7 | 9.73 | 6.34 | 60.8 | 9.73 | 6.35 | 61.0 | 9.73 | 6.37 |
| 11.70 | 59.7 | 9.74 | 6.23 | 59.8 | 9.74 | 6.24 | 60.0 | 9.74 | 6.26 | 60.1 | 9.74 | 6.27 | 60.3 | 9.74 | 6.29 | 60.4 | 9.74 | 6.30 | 60.5 | 9.74 | 6.32 | 60.7 | 9.74 | 6.33 | 60.8 | 9.74 | 6.34 | 61.0 | 9.74 | 6.36 |
| 11.80 | 59.7 | 9.75 | 6.22 | 59.8 | 9.75 | 6.23 | 60.0 | 9.75 | 6.25 | 60.1 | 9.75 | 6.26 | 60.3 | 9.75 | 6.28 | 60.4 | 9.75 | 6.29 | 60.6 | 9.75 | 6.31 | 60.7 | 9.75 | 6.32 | 60.9 | 9.75 | 6.34 | 61.0 | 9.75 | 6.35 |
| 11.90 | 59.7 | 9.76 | 6.21 | 59.9 | 9.76 | 6.22 | 60.0 | 9.76 | 6.24 | 60.1 | 9.76 | 6.25 | 60.3 | 9.76 | 6.27 | 60.4 | 9.76 | 6.28 | 60.6 | 9.76 | 6.30 | 60.7 | 9.76 | 6.31 | 60.9 | 9.76 | 6.33 | 61.0 | 9.76 | 6.34 |
| 12.00 | 59.7 | 9.77 | 6.20 | 59.9 | 9.77 | 6.21 | 60.0 | 9.77 | 6.23 | 60.2 | 9.77 | 6.24 | 60.3 | 9.77 | 6.26 | 60.5 | 9.77 | 6.27 | 60.6 | 9.77 | 6.29 | 60.8 | 9.77 | 6.30 | 60.9 | 9.77 | 6.32 | 61.0 | 9.77 | 6.33 |
| 12.10 | 59.7 | 9.78 | 6.19 | 59.9 | 9.78 | 6.21 | 60.0 | 9.78 | 6.22 | 60.2 | 9.78 | 6.23 | 60.3 | 9.78 | 6.25 | 60.5 | 9.78 | 6.26 | 60.6 | 9.78 | 6.28 | 60.8 | 9.78 | 6.29 | 60.9 | 9.78 | 6.31 | 61.1 | 9.78 | 6.32 |
| 12.30 | 59.8 | 9.81 | 6.17 | 59.9 | 9.81 | 6.19 | 60.1 | 9.81 | 6.20 | 60.2 | 9.81 | 6.22 | 60.4 | 9.81 | 6.23 | 60.5 | 9.81 | 6.25 | 60.7 | 9.81 | 6.26 | 60.8 | 9.81 | 6.27 | 61.0 | 9.81 | 6.29 | 61.1 | 9.81 | 6.30 |
| 12.30 | 59.8 | 9.81 | 6.17 | 59.9 | 9.81 | 6.19 | 60.1 | 9.81 | 6.20 | 60.2 | 9.81 | 6.22 | 60.4 | 9.81 | 6.23 | 60.5 | 9.81 | 6.25 | 60.7 | 9.81 | 6.26 | 60.8 | 9.81 | 6.27 | 61.0 | 9.81 | 6.29 | 61.1 | 9.81 | 6.30 |
| 12.40 | 59.8 | 9.82 | 6.16 | 59.9 | 9.82 | 6.18 | 60.1 | 9.82 | 6.19 | 60.2 | 9.82 | 6.21 | 60.4 | 9.82 | 6.22 | 60.5 | 9.82 | 6.24 | 60.7 | 9.82 | 6.25 | 60.8 | 9.82 | 6.27 | 61.0 | 9.82 | 6.28 | 61.1 | 9.82 | 6.30 |
| 12.50 | 59.8 | 9.83 | 6.15 | 60.0 | 9.83 | 6.17 | 60.1 | 9.83 | 6.18 | 60.3 | 9.83 | 6.20 | 60.4 | 9.83 | 6.21 | 60.6 | 9.83 | 6.23 | 60.7 | 9.83 | 6.24 | 60.8 | 9.83 | 6.26 | 61.0 | 9.83 | 6.27 | 61.1 | 9.83 | 6.29 |
| 12.60 | 59.8 | 9.84 | 6.14 | 60.0 | 9.84 | 6.16 | 60.1 | 9.84 | 6.17 | 60.3 | 9.84 | 6.19 | 60.4 | 9.84 | 6.20 | 60.6 | 9.84 | 6.22 | 60.7 | 9.84 | 6.23 | 60.9 | 9.84 | 6.25 | 61.0 | 9.84 | 6.26 | 61.2 | 9.84 | 6.28 |
| 12.70 | 59.9 | 9.85 | 6.13 | 60.0 | 9.85 | 6.15 | 60.1 | 9.85 | 6.16 | 60.3 | 9.85 | 6.18 | 60.4 | 9.85 | 6.19 | 60.6 | 9.85 | 6.21 | 60.7 | 9.85 | 6.22 | 60.9 | 9.85 | 6.24 | 61.0 | 9.85 | 6.25 | 61.2 | 9.85 | 6.27 |
| 12.80 | 59.9 | 9.86 | 6.12 | 60.0 | 9.86 | 6.14 | 60.2 | 9.86 | 6.15 | 60.3 | 9.86 | 6.17 | 60.5 | 9.86 | 6.18 | 60.6 | 9.86 | 6.20 | 60.8 | 9.86 | 6.21 | 60.9 | 9.86 | 6.23 | 61.1 | 9.86 | 6.24 | 61.2 | 9.86 | 6.26 |
| 12.90 | 59.9 | 9.87 | 6.12 | 60.0 | 9.87 | 6.13 | 60.2 | 9.87 | 6.15 | 60.3 | 9.87 | 6.16 | 60.5 | 9.87 | 6.17 | 60.6 | 9.87 | 6.19 | 60.8 | 9.87 | 6.20 | 60.9 | 9.87 | 6.22 | 61.1 | 9.87 | 6.23 | 61.2 | 9.87 | 6.25 |
| 13.00 | 59.9 | 9.89 | 6.11 | 60.1 | 9.89 | 6.12 | 60.2 | 9.89 | 6.14 | 60.4 | 9.89 | 6.15 | 60.5 | 9.89 | 6.17 | 60.7 | 9.89 | 6.18 | 60.8 | 9.89 | 6.19 | 60.9 | 9.89 | 6.21 | 61.1 | 9.89 | 6.22 | 61.2 | 9.89 | 6.24 |
| 13.10 | 59.9 | 9.90 | 6.10 | 60.1 | 9.90 | 6.11 | 60.2 | 9.90 | 6.13 | 60.4 | 9.90 | 6.14 | 60.5 | 9.90 | 6.16 | 60.7 | 9.90 | 6.17 | 60.8 | 9.90 | 6.19 | 61.0 | 9.90 | 6.20 | 61.1 | 9.90 | 6.22 | 61.3 | 9.90 | 6.23 |
| 13.20 | 59.9 | 9.91 | 6.09 | 60.1 | 9.91 | 6.10 | 60.2 | 9.91 | 6.12 | 60.4 | 9.91 | 6.13 | 60.5 | 9.91 | 6.15 | 60.7 | 9.91 | 6.16 | 60.8 | 9.91 | 6.18 | 61.0 | 9.91 | 6.19 | 61.1 | 9.91 | 6.21 | 61.3 | 9.91 | 6.22 |
| 13.30 | 60.0 | 9.92 | 6.08 | 60.1 | 9.92 | 6.09 | 60.3 | 9.92 | 6.11 | 60.4 | 9.92 | 6.12 | 60.6 | 9.92 | 6.14 | 60.7 | 9.92 | 6.15 | 60.9 | 9.92 | 6.17 | 61.0 | 9.92 | 6.18 | 61.2 | 9.92 | 6.20 | 61.3 | 9.92 | 6.21 |
| 13.40 | 60.0 | 9.93 | 6.07 | 60.1 | 9.93 | 6.08 | 60.3 | 9.93 | 6.10 | 60.4 | 9.93 | 6.11 | 60.6 | 9.93 | 6.13 | 60.7 | 9.93 | 6.14 | 60.9 | 9.93 | 6.16 | 61.0 | 9.93 | 6.17 | 61.2 | 9.93 | 6.19 | 61.3 | 9.93 | 6.20 |
| 13.50 | 60.0 | 9.94 | 6.06 | 60.2 | 9.94 | 6.07 | 60.3 | 9.94 | 6.09 | 60.5 | 9.94 | 6.10 | 60.6 | 9.94 | 6.12 | 60.8 | 9.94 | 6.13 | 60.9 | 9.94 | 6.15 | 61.0 | 9.94 | 6.16 | 61.2 | 9.94 | 6.18 | 61.3 | 9.94 | 6.19 |
| 13.60 | 60.0 | 9.95 | 6.05 | 60.2 | 9.95 | 6.06 | 60.3 | 9.95 | 6.08 | 60.5 | 9.95 | 6.09 | 60.6 | 9.95 | 6.11 | 60.8 | 9.95 | 6.12 | 60.9 | 9.95 | 6.14 | 61.1 | 9.95 | 6.15 | 61.2 | 9.95 | 6.17 | 61.4 | 9.95 | 6.18 |
| 13.70 | 60.0 | 9.97 | 6.04 | 60.2 | 9.97 | 6.05 | 60.3 | 9.97 | 6.07 | 60.5 | 9.97 | 6.08 | 60.6 | 9.97 | 6.10 | 60.8 | 9.97 | 6.11 | 60.9 | 9.97 | 6.13 | 61.1 | 9.97 | 6.14 | 61.2 | 9.97 | 6.16 | 61.4 | 9.97 | 6.17 |
| 13.80 | 60.1 | 9.98 | 6.03 | 60.2 | 9.98 | 6.04 | 60.4 | 9.98 | 6.06 | 60.5 | 9.98 | 6.07 | 60.7 | 9.98 | 6.09 | 60.8 | 9.98 | 6.10 | 61.0 | 9.98 | 6.12 | 61.1 | 9.98 | 6.13 | 61.3 | 9.98 | 6.15 | 61.4 | 9.98 | 6.16 |
| 13.90 | 60.1 | 9.99 | 6.02 | 60.2 | 9.99 | 6.03 | 60.4 | 9.99 | 6.05 | 60.5 | 9.99 | 6.06 | 60.7 | 9.99 | 6.08 | 60.8 | 9.99 | 6.09 | 61.0 | 9.99 | 6.11 | 61.1 | 9.99 | 6.12 | 61.3 | 9.99 | 6.14 | 61.4 | 9.99 | 6.15 |
| 14.00 | 60.1 | 10.00 | 6.01 | 60.3 | 10.00 | 6.03 | 60.4 | 10.00 | 6.04 | 60.6 | 10.00 | 6.06 | 60.7 | 10.00 | 6.07 | 60.9 | 10.00 | 6.09 | 61.0 | 10.00 | 6.10 | 61.2 | 10.00 | 6.12 | 61.3 | 10.00 | 6.13 | 61.5 | 10.00 | 6.15 |
| 14.10 | 60.1 | 10.01 | 6.00 | 60.3 | 10.01 | 6.02 | 60.4 | 10.01 | 6.03 | 60.6 | 10.01 | 6.05 | 60.7 | 10.01 | 6.06 | 60.9 | 10.01 | 6.08 | 61.0 | 10.01 | 6.09 | 61.2 | 10.01 | 6.11 | 61.3 | 10.01 | 6.12 | 61.5 | 10.01 | 6.14 |
| 14.20 | 60.1 | 10.02 | 5.99 | 60.3 | 10.02 | 6.01 | 60.4 | 10.02 | 6.02 | 60.6 | 10.02 | 6.04 | 60.7 | 10.02 | 6.05 | 60.9 | 10.02 | 6.07 | 61.0 | 10.02 | 6.08 | 61.2 | 10.02 | 6.10 | 61.3 | 10.02 | 6.11 | 61.5 | 10.02 | 6.13 |
| 14.30 | 60.2 | 10.04 | 5.98 | 60.3 | 10.04 | 6.00 | 60.5 | 10.04 | 6.01 | 60.6 | 10.04 | 6.03 | 60.8 | 10.04 | 6.04 | 60.9 | 10.04 | 6.06 | 61.1 | 10.04 | 6.07 | 61.2 | 10.04 | 6.09 | 61.4 | 10.04 | 6.10 | 61.5 | 10.04 | 6.12 |
| 14.40 | 60.2 | 10.05 | 5.97 | 60.3 | 10.05 | 5.99 | 60.5 | 10.05 | 6.00 | 60.6 | 10.05 | 6.02 | 60.8 | 10.05 | 6.03 | 60.9 | 10.05 | 6.05 | 61.1 | 10.05 | 6.06 | 61.2 | 10.05 | 6.08 | 61.4 | 10.05 | 6.09 | 61.5 | 10.05 | 6.11 |
| 14.50 | 60.2 | 10.06 | 5.96 | 60.3 | 10.06 | 5.98 | 60.5 | 10.06 | 5.99 | 60.6 | 10.06 | 6.01 | 60.8 | 10.06 | 6.02 | 61.0 | 10.06 | 6.04 | 61.1 | 10.06 | 6.05 | 61.3 | 10.06 | 6.07 | 61.4 | 10.06 | 6.08 | 61.6 | 10.06 | 6.10 |
| 14.60 | 60.2 | 10.07 | 5.95 | 60.4 | 10.07 | 5.97 | 60.5 | 10.07 | 5.98 | 60.7 | 10.07 | 6.00 | 60.8 | 10.07 | 6.01 | 61.0 | 10.07 | 6.03 | 61.1 | 10.07 | 6.04 | 61.3 | 10.07 | 6.06 | 61.4 | 10.07 | 6.07 | 61.6 | 10.07 | 6.09 |
| 14.70 | 60.2 | 10.08 | 5.94 | 60.4 | 10.08 | 5.96 | 60.5 | 10.08 | 5.97 | 60.7 | 10.08 | 5.99 | 60.8 | 10.08 | 6.00 | 61.0 | 10.08 | 6.02 | 61.1 | 10.08 | 6.03 | 61.3 | 10.08 | 6.05 | 61.4 | 10.08 | 6.06 | 61.6 | 10.08 | 6.08 |
| 14.80 | 60.3 | 10.09 | 5.93 | 60.4 | 10.09 | 5.95 | 60.6 | 10.09 | 5.96 | 60.7 | 10.09 | 5.98 | 60.9 | 10.09 | 5.99 | 61.0 | 10.09 | 6.01 | 61.2 | 10.09 | 6.02 | 61.3 | 10.09 | 6.04 | 61.5 | 10.09 | 6.05 | 61.6 | 10.09 | 6.07 |
| 14.90 | 60.3 | 10.11 | 5.92 | 60.4 | 10.11 | 5.94 | 60.6 | 10.11 | 5.95 | 60.7 | 10.11 | 5.97 | 60.9 | 10.11 | 5.98 | 61.0 | 10.11 | 6.00 | 61.2 | 10.11 | 6.01 | 61.3 | 10.11 | 6.03 | 61.5 | 10.11 | 6.04 | 61.6 | 10.11 | 6.06 |
| 15.00 | 60.3 | 10.12 | 5.91 | 60.4 | 10.12 | 5.93 | 60.6 | 10.12 | 5.94 | 60.7 | 10.12 | 5.96 | 60.9 | 10.12 | 5.97 | 61.1 | 10.12 | 5.99 | 61.2 | 10.12 | 6.00 | 61.4 | 10.12 | 6.02 | 61.5 | 10.12 | 6.03 | 61.7 | 10.12 | 6.05 |
| 15.10 | 60.3 | 10.13 | 5.90 | 60.5 | 10.13 | 5.92 | 60.6 | 10.13 | 5.93 | 60.8 | 10.13 | 5.95 | 60.9 | 10.13 | 5.96 | 61.1 | 10.13 | 5.98 | 61.2 | 10.13 | 5.99 | 61.4 | 10.13 | 6.01 | 61.5 | 10.13 | 6.02 | 61.7 | 10.13 | 6.04 |
| 15.20 | 60.3 | 10.14 | 5.89 | 60.5 | 10.14 | 5.91 | 60.6 | 10.14 | 5.92 | 60.8 | 10.14 | 5.94 | 60.9 | 10.14 | 5.95 | 61.1 | 10.14 | 5.97 | 61.2 | 10.14 | 5.98 | 61.4 | 10.14 | 6.00 | 61.6 | 10.14 | 6.01 | 61.7 | 10.14 | 6.03 |
| 15.30 | 60.4 | 10.15 | 5.88 | 60.5 | 10.15 | 5.90 | 60.7 | 10.15 | 5.91 | 60.8 | 10.15 | 5.93 | 61.0 | 10.15 | 5.94 | 61.1 | 10.15 | 5.96 | 61.3 | 10.15 | 5.97 | 61.4 | 10.15 | 5.99 | 61.6 | 10.15 | 6.00 | 61.7 | 10.15 | 6.02 |
| 15.40 | 60.4 | 10.17 | 5.87 | 60.5 | 10.17 | 5.89 | 60.7 | 10.17 | 5.90 | 60.8 | 10.17 | 5.92 | 61.0 | 10.17 | 5.93 | 61.1 | 10.17 | 5.95 | 61.3 | 10.17 | 5.96 | 61.4 | 10.17 | 5.98 | 61.6 | 10.17 | 5.99 | 61.7 | 10.17 | 6.01 |
| 15.50 | 60.4 | 10.18 | 5.86 | 60.5 | 10.18 | 5.88 | 60.7 | 10.18 | 5.89 | 60.9 | 10.18 | 5.91 | 61.0 | 10.18 | 5.92 | 61.2 | 10.18 | 5.94 | 61.3 | 10.18 | 5.95 | 61.5 | 10.18 | 5.97 | 61.6 | 10.18 | 5.98 | 61.8 | 10.18 | 6.00 |
| 15.60 | 60.4 | 10.19 | 5.85 | 60.6 | 10.19 | 5.87 | 60.7 | 10.19 | 5.88 | 60.9 | 10.19 | 5.90 | 61.0 | 10.19 | 5.91 | 61.2 | 10.19 | 5.93 | 61.3 | 10.19 | 5.94 | 61.5 | 10.19 | 5.96 | 61.6 | 10.19 | 5.97 | 61.8 | 10.19 | 5.99 |
| 15.70 | 60.4 | 10.20 | 5.84 | 60.6 | 10.20 | 5.86 | 60.7 | 10.20 | 5.87 | 60.9 | 10.20 | 5.89 | 61.0 | 10.20 | 5.90 | 61.2 | 10.20 | 5.92 | 61.4 | 10.20 | 5.93 | 61.5 | 10.20 | 5.95 | 61.7 | 10.20 | 5.96 | 61.8 | 10.20 | 5.98 |
| 15.80 | 60.5 | 10.21 | 5.83 | 60.6 | 10.21 | 5.85 | 60.8 | 10.21 | 5.86 | 60.9 | 10.21 | 5.88 | 61.1 | 10.21 | 5.89 | 61.2 | 10.21 | 5.91 | 61.4 | 10.21 | 5.92 | 61.5 | 10.21 | 5.94 | 61.7 | 10.21 | 5.95 | 61.8 | 10.21 | 5.97 |
| 15.90 | 60.5 | 10.23 | 5.82 | 60.6 | 10.23 | 5.84 | 60.8 | 10.23 | 5.85 | 60.9 | 10.23 | 5.87 | 61.1 | 10.23 | 5.88 | 61.2 | 10.23 | 5.90 | 61.4 | 10.23 | 5.91 | 61.5 | 10.23 | 5.93 | 61.7 | 10.23 | 5.94 | 61.9 | 10.23 | 5.96 |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 10.0; Water (ml) = (% Absorption x 10.0 / 100) + (10.0 - sample weight)

## 10-gram Mixograph: Absorption, Flour and Water Amount Table
## (12.0 - 12.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 12.00 | | | 12.10 | | | 12.20 | | | 12.30 | | | 12.40 | | | 12.50 | | | 12.60 | | | 12.70 | | | 12.80 | | | 12.90 | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml |
| 9.00 | 60.6 | 9.45 | 6.61 | 60.8 | 9.45 | 6.62 | 60.9 | 9.45 | 6.64 | 61.0 | 9.45 | 6.65 | 61.2 | 9.45 | 6.67 | 61.3 | 9.45 | 6.68 | 61.5 | 9.45 | 6.70 | 61.6 | 9.45 | 6.71 | 61.7 | 9.45 | 6.72 | 61.9 | 9.45 | 6.74 |
| 9.10 | 60.6 | 9.46 | 6.60 | 60.8 | 9.46 | 6.62 | 60.9 | 9.46 | 6.63 | 61.1 | 9.46 | 6.64 | 61.2 | 9.46 | 6.66 | 61.3 | 9.46 | 6.67 | 61.5 | 9.46 | 6.69 | 61.6 | 9.46 | 6.70 | 61.8 | 9.46 | 6.72 | 61.9 | 9.46 | 6.73 |
| 9.20 | 60.6 | 9.47 | 6.59 | 60.8 | 9.47 | 6.61 | 60.9 | 9.47 | 6.62 | 61.1 | 9.47 | 6.64 | 61.2 | 9.47 | 6.65 | 61.4 | 9.47 | 6.66 | 61.5 | 9.47 | 6.68 | 61.6 | 9.47 | 6.69 | 61.8 | 9.47 | 6.71 | 61.9 | 9.47 | 6.72 |
| 9.30 | 60.7 | 9.48 | 6.58 | 60.8 | 9.48 | 6.60 | 61.0 | 9.48 | 6.61 | 61.1 | 9.48 | 6.63 | 61.2 | 9.48 | 6.64 | 61.4 | 9.48 | 6.66 | 61.5 | 9.48 | 6.67 | 61.7 | 9.48 | 6.68 | 61.8 | 9.48 | 6.70 | 61.9 | 9.48 | 6.71 |
| 9.40 | 60.7 | 9.49 | 6.58 | 60.8 | 9.49 | 6.59 | 61.0 | 9.49 | 6.60 | 61.1 | 9.49 | 6.62 | 61.3 | 9.49 | 6.63 | 61.4 | 9.49 | 6.65 | 61.5 | 9.49 | 6.66 | 61.7 | 9.49 | 6.68 | 61.8 | 9.49 | 6.69 | 62.0 | 9.49 | 6.70 |
| 9.50 | 60.7 | 9.50 | 6.57 | 60.8 | 9.50 | 6.58 | 61.0 | 9.50 | 6.60 | 61.1 | 9.50 | 6.61 | 61.3 | 9.50 | 6.62 | 61.4 | 9.50 | 6.64 | 61.6 | 9.50 | 6.65 | 61.7 | 9.50 | 6.67 | 61.8 | 9.50 | 6.68 | 62.0 | 9.50 | 6.70 |
| 9.60 | 60.7 | 9.51 | 6.56 | 60.9 | 9.51 | 6.57 | 61.0 | 9.51 | 6.59 | 61.2 | 9.51 | 6.60 | 61.3 | 9.51 | 6.62 | 61.4 | 9.51 | 6.63 | 61.6 | 9.51 | 6.64 | 61.7 | 9.51 | 6.66 | 61.9 | 9.51 | 6.67 | 62.0 | 9.51 | 6.69 |
| 9.70 | 60.7 | 9.52 | 6.55 | 60.9 | 9.52 | 6.56 | 61.0 | 9.52 | 6.58 | 61.2 | 9.52 | 6.59 | 61.3 | 9.52 | 6.61 | 61.5 | 9.52 | 6.62 | 61.6 | 9.52 | 6.64 | 61.7 | 9.52 | 6.65 | 61.9 | 9.52 | 6.66 | 62.0 | 9.52 | 6.68 |
| 9.80 | 60.8 | 9.53 | 6.54 | 60.9 | 9.53 | 6.56 | 61.0 | 9.53 | 6.57 | 61.2 | 9.53 | 6.58 | 61.3 | 9.53 | 6.60 | 61.5 | 9.53 | 6.61 | 61.6 | 9.53 | 6.63 | 61.8 | 9.53 | 6.64 | 61.9 | 9.53 | 6.66 | 62.0 | 9.53 | 6.67 |
| 9.90 | 60.8 | 9.54 | 6.53 | 60.9 | 9.54 | 6.55 | 61.1 | 9.54 | 6.56 | 61.2 | 9.54 | 6.58 | 61.4 | 9.54 | 6.59 | 61.5 | 9.54 | 6.60 | 61.6 | 9.54 | 6.62 | 61.8 | 9.54 | 6.63 | 61.9 | 9.54 | 6.65 | 62.1 | 9.54 | 6.66 |
| 10.00 | 60.8 | 9.56 | 6.52 | 60.9 | 9.56 | 6.54 | 61.1 | 9.56 | 6.55 | 61.2 | 9.56 | 6.57 | 61.4 | 9.56 | 6.58 | 61.5 | 9.56 | 6.60 | 61.7 | 9.56 | 6.61 | 61.8 | 9.56 | 6.62 | 61.9 | 9.56 | 6.64 | 62.1 | 9.56 | 6.65 |
| 10.10 | 60.8 | 9.57 | 6.52 | 61.0 | 9.57 | 6.53 | 61.1 | 9.57 | 6.54 | 61.2 | 9.57 | 6.56 | 61.4 | 9.57 | 6.57 | 61.5 | 9.57 | 6.59 | 61.7 | 9.57 | 6.60 | 61.8 | 9.57 | 6.62 | 62.0 | 9.57 | 6.63 | 62.1 | 9.57 | 6.64 |
| 10.20 | 60.8 | 9.58 | 6.51 | 61.0 | 9.58 | 6.52 | 61.1 | 9.58 | 6.54 | 61.3 | 9.58 | 6.55 | 61.4 | 9.58 | 6.56 | 61.6 | 9.58 | 6.58 | 61.7 | 9.58 | 6.59 | 61.8 | 9.58 | 6.61 | 62.0 | 9.58 | 6.62 | 62.1 | 9.58 | 6.64 |
| 10.30 | 60.9 | 9.59 | 6.50 | 61.0 | 9.59 | 6.51 | 61.1 | 9.59 | 6.53 | 61.3 | 9.59 | 6.54 | 61.4 | 9.59 | 6.56 | 61.6 | 9.59 | 6.57 | 61.7 | 9.59 | 6.58 | 61.9 | 9.59 | 6.60 | 62.0 | 9.59 | 6.61 | 62.2 | 9.59 | 6.63 |
| 10.40 | 60.9 | 9.60 | 6.49 | 61.0 | 9.60 | 6.50 | 61.2 | 9.60 | 6.52 | 61.3 | 9.60 | 6.53 | 61.5 | 9.60 | 6.55 | 61.6 | 9.60 | 6.56 | 61.7 | 9.60 | 6.58 | 61.9 | 9.60 | 6.59 | 62.0 | 9.60 | 6.60 | 62.2 | 9.60 | 6.62 |
| 10.50 | 60.9 | 9.61 | 6.48 | 61.0 | 9.61 | 6.50 | 61.2 | 9.61 | 6.51 | 61.3 | 9.61 | 6.52 | 61.5 | 9.61 | 6.54 | 61.6 | 9.61 | 6.55 | 61.8 | 9.61 | 6.57 | 61.9 | 9.61 | 6.58 | 62.0 | 9.61 | 6.60 | 62.2 | 9.61 | 6.61 |
| 10.60 | 60.9 | 9.62 | 6.47 | 61.1 | 9.62 | 6.49 | 61.2 | 9.62 | 6.50 | 61.3 | 9.62 | 6.52 | 61.5 | 9.62 | 6.53 | 61.6 | 9.62 | 6.54 | 61.8 | 9.62 | 6.56 | 61.9 | 9.62 | 6.57 | 62.1 | 9.62 | 6.59 | 62.2 | 9.62 | 6.60 |
| 10.70 | 60.9 | 9.63 | 6.46 | 61.1 | 9.63 | 6.48 | 61.2 | 9.63 | 6.49 | 61.4 | 9.63 | 6.51 | 61.5 | 9.63 | 6.52 | 61.7 | 9.63 | 6.54 | 61.8 | 9.63 | 6.55 | 61.9 | 9.63 | 6.56 | 62.1 | 9.63 | 6.58 | 62.2 | 9.63 | 6.59 |
| 10.80 | 61.0 | 9.64 | 6.45 | 61.1 | 9.64 | 6.47 | 61.2 | 9.64 | 6.48 | 61.4 | 9.64 | 6.50 | 61.5 | 9.64 | 6.51 | 61.7 | 9.64 | 6.53 | 61.8 | 9.64 | 6.54 | 62.0 | 9.64 | 6.56 | 62.1 | 9.64 | 6.57 | 62.3 | 9.64 | 6.58 |
| 10.90 | 61.0 | 9.65 | 6.45 | 61.1 | 9.65 | 6.46 | 61.3 | 9.65 | 6.47 | 61.4 | 9.65 | 6.49 | 61.6 | 9.65 | 6.50 | 61.7 | 9.65 | 6.52 | 61.8 | 9.65 | 6.53 | 62.0 | 9.65 | 6.55 | 62.1 | 9.65 | 6.56 | 62.3 | 9.65 | 6.58 |
| 11.00 | 61.0 | 9.66 | 6.44 | 61.1 | 9.66 | 6.45 | 61.3 | 9.66 | 6.47 | 61.4 | 9.66 | 6.48 | 61.6 | 9.66 | 6.49 | 61.7 | 9.66 | 6.51 | 61.9 | 9.66 | 6.52 | 62.0 | 9.66 | 6.54 | 62.2 | 9.66 | 6.55 | 62.3 | 9.66 | 6.57 |
| 11.10 | 61.0 | 9.67 | 6.43 | 61.2 | 9.67 | 6.44 | 61.3 | 9.67 | 6.46 | 61.4 | 9.67 | 6.47 | 61.6 | 9.67 | 6.49 | 61.7 | 9.67 | 6.50 | 61.9 | 9.67 | 6.51 | 62.0 | 9.67 | 6.53 | 62.2 | 9.67 | 6.54 | 62.3 | 9.67 | 6.56 |
| 11.20 | 61.0 | 9.68 | 6.42 | 61.2 | 9.68 | 6.43 | 61.3 | 9.68 | 6.45 | 61.5 | 9.68 | 6.46 | 61.6 | 9.68 | 6.48 | 61.8 | 9.68 | 6.49 | 61.9 | 9.68 | 6.51 | 62.0 | 9.68 | 6.52 | 62.2 | 9.68 | 6.53 | 62.3 | 9.68 | 6.55 |
| 11.30 | 61.1 | 9.70 | 6.41 | 61.2 | 9.70 | 6.42 | 61.3 | 9.70 | 6.44 | 61.5 | 9.70 | 6.45 | 61.6 | 9.70 | 6.47 | 61.8 | 9.70 | 6.48 | 61.9 | 9.70 | 6.50 | 62.1 | 9.70 | 6.51 | 62.2 | 9.70 | 6.53 | 62.4 | 9.70 | 6.54 |
| 11.40 | 61.1 | 9.71 | 6.40 | 61.2 | 9.71 | 6.42 | 61.4 | 9.71 | 6.43 | 61.5 | 9.71 | 6.44 | 61.7 | 9.71 | 6.46 | 61.8 | 9.71 | 6.47 | 61.9 | 9.71 | 6.49 | 62.1 | 9.71 | 6.50 | 62.2 | 9.71 | 6.52 | 62.4 | 9.71 | 6.53 |
| 11.50 | 61.1 | 9.72 | 6.39 | 61.2 | 9.72 | 6.41 | 61.4 | 9.72 | 6.42 | 61.5 | 9.72 | 6.44 | 61.7 | 9.72 | 6.45 | 61.8 | 9.72 | 6.46 | 62.0 | 9.72 | 6.48 | 62.1 | 9.72 | 6.49 | 62.3 | 9.72 | 6.51 | 62.4 | 9.72 | 6.52 |
| 11.60 | 61.1 | 9.73 | 6.38 | 61.3 | 9.73 | 6.40 | 61.4 | 9.73 | 6.41 | 61.5 | 9.73 | 6.43 | 61.7 | 9.73 | 6.44 | 61.8 | 9.73 | 6.46 | 62.0 | 9.73 | 6.47 | 62.1 | 9.73 | 6.48 | 62.3 | 9.73 | 6.50 | 62.4 | 9.73 | 6.51 |
| 11.70 | 61.1 | 9.74 | 6.37 | 61.3 | 9.74 | 6.39 | 61.4 | 9.74 | 6.40 | 61.6 | 9.74 | 6.42 | 61.7 | 9.74 | 6.43 | 61.9 | 9.74 | 6.45 | 62.0 | 9.74 | 6.46 | 62.2 | 9.74 | 6.48 | 62.3 | 9.74 | 6.49 | 62.4 | 9.74 | 6.51 |
| 11.80 | 61.2 | 9.75 | 6.36 | 61.3 | 9.75 | 6.38 | 61.4 | 9.75 | 6.39 | 61.6 | 9.75 | 6.41 | 61.7 | 9.75 | 6.42 | 61.9 | 9.75 | 6.44 | 62.0 | 9.75 | 6.45 | 62.2 | 9.75 | 6.47 | 62.3 | 9.75 | 6.48 | 62.5 | 9.75 | 6.50 |
| 11.90 | 61.2 | 9.76 | 6.36 | 61.3 | 9.76 | 6.37 | 61.5 | 9.76 | 6.38 | 61.6 | 9.76 | 6.40 | 61.8 | 9.76 | 6.41 | 61.9 | 9.76 | 6.43 | 62.0 | 9.76 | 6.44 | 62.2 | 9.76 | 6.46 | 62.3 | 9.76 | 6.47 | 62.5 | 9.76 | 6.49 |
| 12.00 | 61.2 | 9.77 | 6.35 | 61.3 | 9.77 | 6.36 | 61.5 | 9.77 | 6.38 | 61.6 | 9.77 | 6.39 | 61.8 | 9.77 | 6.41 | 61.9 | 9.77 | 6.42 | 62.1 | 9.77 | 6.43 | 62.2 | 9.77 | 6.45 | 62.4 | 9.77 | 6.46 | 62.5 | 9.77 | 6.48 |
| 12.10 | 61.2 | 9.78 | 6.34 | 61.4 | 9.78 | 6.35 | 61.5 | 9.78 | 6.37 | 61.7 | 9.78 | 6.38 | 61.8 | 9.78 | 6.40 | 61.9 | 9.78 | 6.41 | 62.1 | 9.78 | 6.43 | 62.2 | 9.78 | 6.44 | 62.4 | 9.78 | 6.45 | 62.5 | 9.78 | 6.47 |
| 12.30 | 61.3 | 9.81 | 6.32 | 61.4 | 9.81 | 6.33 | 61.5 | 9.81 | 6.35 | 61.7 | 9.81 | 6.36 | 61.8 | 9.81 | 6.38 | 62.0 | 9.81 | 6.39 | 62.1 | 9.81 | 6.41 | 62.3 | 9.81 | 6.42 | 62.4 | 9.81 | 6.44 | 62.6 | 9.81 | 6.45 |
| 12.30 | 61.3 | 9.81 | 6.32 | 61.4 | 9.81 | 6.33 | 61.5 | 9.81 | 6.35 | 61.7 | 9.81 | 6.36 | 61.8 | 9.81 | 6.38 | 62.0 | 9.81 | 6.39 | 62.1 | 9.81 | 6.41 | 62.3 | 9.81 | 6.42 | 62.4 | 9.81 | 6.44 | 62.6 | 9.81 | 6.45 |
| 12.40 | 61.3 | 9.82 | 6.31 | 61.4 | 9.82 | 6.32 | 61.6 | 9.82 | 6.34 | 61.7 | 9.82 | 6.35 | 61.9 | 9.82 | 6.37 | 62.0 | 9.82 | 6.38 | 62.2 | 9.82 | 6.40 | 62.3 | 9.82 | 6.41 | 62.4 | 9.82 | 6.43 | 62.6 | 9.82 | 6.44 |
| 12.50 | 61.3 | 9.83 | 6.30 | 61.4 | 9.83 | 6.32 | 61.6 | 9.83 | 6.33 | 61.7 | 9.83 | 6.34 | 61.9 | 9.83 | 6.36 | 62.0 | 9.83 | 6.37 | 62.2 | 9.83 | 6.39 | 62.3 | 9.83 | 6.40 | 62.5 | 9.83 | 6.42 | 62.6 | 9.83 | 6.43 |
| 12.60 | 61.3 | 9.84 | 6.29 | 61.5 | 9.84 | 6.31 | 61.6 | 9.84 | 6.32 | 61.8 | 9.84 | 6.34 | 61.9 | 9.84 | 6.35 | 62.0 | 9.84 | 6.37 | 62.2 | 9.84 | 6.38 | 62.3 | 9.84 | 6.39 | 62.5 | 9.84 | 6.41 | 62.6 | 9.84 | 6.42 |
| 12.70 | 61.3 | 9.85 | 6.28 | 61.5 | 9.85 | 6.30 | 61.6 | 9.85 | 6.31 | 61.8 | 9.85 | 6.33 | 61.9 | 9.85 | 6.34 | 62.1 | 9.85 | 6.36 | 62.2 | 9.85 | 6.37 | 62.4 | 9.85 | 6.39 | 62.5 | 9.85 | 6.40 | 62.7 | 9.85 | 6.42 |
| 12.80 | 61.4 | 9.86 | 6.27 | 61.5 | 9.86 | 6.29 | 61.6 | 9.86 | 6.30 | 61.8 | 9.86 | 6.32 | 61.9 | 9.86 | 6.33 | 62.1 | 9.86 | 6.35 | 62.2 | 9.86 | 6.36 | 62.4 | 9.86 | 6.38 | 62.5 | 9.86 | 6.39 | 62.7 | 9.86 | 6.41 |
| 12.90 | 61.4 | 9.87 | 6.26 | 61.5 | 9.87 | 6.28 | 61.7 | 9.87 | 6.29 | 61.8 | 9.87 | 6.31 | 62.0 | 9.87 | 6.32 | 62.1 | 9.87 | 6.34 | 62.3 | 9.87 | 6.35 | 62.4 | 9.87 | 6.37 | 62.6 | 9.87 | 6.38 | 62.7 | 9.87 | 6.40 |
| 13.00 | 61.4 | 9.89 | 6.25 | 61.5 | 9.89 | 6.27 | 61.7 | 9.89 | 6.28 | 61.8 | 9.89 | 6.30 | 62.0 | 9.89 | 6.31 | 62.1 | 9.89 | 6.33 | 62.3 | 9.89 | 6.34 | 62.4 | 9.89 | 6.36 | 62.6 | 9.89 | 6.37 | 62.7 | 9.89 | 6.39 |
| 13.10 | 61.4 | 9.90 | 6.24 | 61.6 | 9.90 | 6.26 | 61.7 | 9.90 | 6.27 | 61.9 | 9.90 | 6.29 | 62.0 | 9.90 | 6.30 | 62.2 | 9.90 | 6.32 | 62.3 | 9.90 | 6.33 | 62.5 | 9.90 | 6.35 | 62.6 | 9.90 | 6.36 | 62.7 | 9.90 | 6.38 |
| 13.20 | 61.4 | 9.91 | 6.24 | 61.6 | 9.91 | 6.25 | 61.7 | 9.91 | 6.27 | 61.9 | 9.91 | 6.28 | 62.0 | 9.91 | 6.30 | 62.2 | 9.91 | 6.31 | 62.3 | 9.91 | 6.32 | 62.5 | 9.91 | 6.34 | 62.6 | 9.91 | 6.35 | 62.8 | 9.91 | 6.37 |
| 13.30 | 61.5 | 9.92 | 6.23 | 61.6 | 9.92 | 6.24 | 61.8 | 9.92 | 6.26 | 61.9 | 9.92 | 6.27 | 62.0 | 9.92 | 6.29 | 62.2 | 9.92 | 6.30 | 62.3 | 9.92 | 6.32 | 62.5 | 9.92 | 6.33 | 62.6 | 9.92 | 6.35 | 62.8 | 9.92 | 6.36 |
| 13.40 | 61.5 | 9.93 | 6.22 | 61.6 | 9.93 | 6.23 | 61.8 | 9.93 | 6.25 | 61.9 | 9.93 | 6.26 | 62.1 | 9.93 | 6.28 | 62.2 | 9.93 | 6.29 | 62.4 | 9.93 | 6.31 | 62.5 | 9.93 | 6.32 | 62.7 | 9.93 | 6.34 | 62.8 | 9.93 | 6.35 |
| 13.50 | 61.5 | 9.94 | 6.21 | 61.6 | 9.94 | 6.22 | 61.8 | 9.94 | 6.24 | 61.9 | 9.94 | 6.25 | 62.1 | 9.94 | 6.27 | 62.2 | 9.94 | 6.28 | 62.4 | 9.94 | 6.30 | 62.5 | 9.94 | 6.31 | 62.7 | 9.94 | 6.33 | 62.8 | 9.94 | 6.34 |
| 13.60 | 61.5 | 9.95 | 6.20 | 61.7 | 9.95 | 6.21 | 61.8 | 9.95 | 6.23 | 62.0 | 9.95 | 6.24 | 62.1 | 9.95 | 6.26 | 62.3 | 9.95 | 6.27 | 62.4 | 9.95 | 6.29 | 62.6 | 9.95 | 6.30 | 62.7 | 9.95 | 6.32 | 62.9 | 9.95 | 6.33 |
| 13.70 | 61.5 | 9.97 | 6.19 | 61.7 | 9.97 | 6.20 | 61.8 | 9.97 | 6.22 | 62.0 | 9.97 | 6.23 | 62.1 | 9.97 | 6.25 | 62.3 | 9.97 | 6.26 | 62.4 | 9.97 | 6.28 | 62.6 | 9.97 | 6.29 | 62.7 | 9.97 | 6.31 | 62.9 | 9.97 | 6.32 |
| 13.80 | 61.6 | 9.98 | 6.18 | 61.7 | 9.98 | 6.19 | 61.9 | 9.98 | 6.21 | 62.0 | 9.98 | 6.22 | 62.2 | 9.98 | 6.24 | 62.3 | 9.98 | 6.25 | 62.5 | 9.98 | 6.27 | 62.6 | 9.98 | 6.28 | 62.8 | 9.98 | 6.30 | 62.9 | 9.98 | 6.31 |
| 13.90 | 61.6 | 9.99 | 6.17 | 61.7 | 9.99 | 6.18 | 61.9 | 9.99 | 6.20 | 62.0 | 9.99 | 6.21 | 62.2 | 9.99 | 6.23 | 62.3 | 9.99 | 6.24 | 62.5 | 9.99 | 6.26 | 62.6 | 9.99 | 6.27 | 62.8 | 9.99 | 6.29 | 62.9 | 9.99 | 6.30 |
| 14.00 | 61.6 | 10.00 | 6.16 | 61.8 | 10.00 | 6.18 | 61.9 | 10.00 | 6.19 | 62.1 | 10.00 | 6.21 | 62.2 | 10.00 | 6.22 | 62.4 | 10.00 | 6.24 | 62.5 | 10.00 | 6.25 | 62.7 | 10.00 | 6.27 | 62.8 | 10.00 | 6.28 | 63.0 | 10.00 | 6.30 |
| 14.10 | 61.6 | 10.01 | 6.15 | 61.8 | 10.01 | 6.17 | 61.9 | 10.01 | 6.18 | 62.1 | 10.01 | 6.20 | 62.2 | 10.01 | 6.21 | 62.4 | 10.01 | 6.23 | 62.5 | 10.01 | 6.24 | 62.7 | 10.01 | 6.26 | 62.8 | 10.01 | 6.27 | 63.0 | 10.01 | 6.29 |
| 14.20 | 61.6 | 10.02 | 6.14 | 61.8 | 10.02 | 6.16 | 61.9 | 10.02 | 6.17 | 62.1 | 10.02 | 6.19 | 62.2 | 10.02 | 6.20 | 62.4 | 10.02 | 6.22 | 62.5 | 10.02 | 6.23 | 62.7 | 10.02 | 6.25 | 62.8 | 10.02 | 6.26 | 63.0 | 10.02 | 6.28 |
| 14.30 | 61.7 | 10.04 | 6.13 | 61.8 | 10.04 | 6.15 | 62.0 | 10.04 | 6.16 | 62.1 | 10.04 | 6.18 | 62.3 | 10.04 | 6.19 | 62.4 | 10.04 | 6.21 | 62.6 | 10.04 | 6.22 | 62.7 | 10.04 | 6.24 | 62.9 | 10.04 | 6.25 | 63.0 | 10.04 | 6.27 |
| 14.40 | 61.7 | 10.05 | 6.12 | 61.8 | 10.05 | 6.14 | 62.0 | 10.05 | 6.15 | 62.1 | 10.05 | 6.17 | 62.3 | 10.05 | 6.18 | 62.4 | 10.05 | 6.20 | 62.6 | 10.05 | 6.21 | 62.7 | 10.05 | 6.23 | 62.9 | 10.05 | 6.24 | 63.0 | 10.05 | 6.26 |
| 14.50 | 61.7 | 10.06 | 6.11 | 61.9 | 10.06 | 6.13 | 62.0 | 10.06 | 6.14 | 62.2 | 10.06 | 6.16 | 62.3 | 10.06 | 6.17 | 62.5 | 10.06 | 6.19 | 62.6 | 10.06 | 6.20 | 62.8 | 10.06 | 6.22 | 62.9 | 10.06 | 6.23 | 63.1 | 10.06 | 6.25 |
| 14.60 | 61.7 | 10.07 | 6.10 | 61.9 | 10.07 | 6.12 | 62.0 | 10.07 | 6.13 | 62.2 | 10.07 | 6.15 | 62.3 | 10.07 | 6.16 | 62.5 | 10.07 | 6.18 | 62.6 | 10.07 | 6.19 | 62.8 | 10.07 | 6.21 | 62.9 | 10.07 | 6.22 | 63.1 | 10.07 | 6.24 |
| 14.70 | 61.7 | 10.08 | 6.09 | 61.9 | 10.08 | 6.11 | 62.1 | 10.08 | 6.12 | 62.2 | 10.08 | 6.14 | 62.4 | 10.08 | 6.15 | 62.5 | 10.08 | 6.17 | 62.7 | 10.08 | 6.18 | 62.8 | 10.08 | 6.20 | 63.0 | 10.08 | 6.21 | 63.1 | 10.08 | 6.23 |
| 14.80 | 61.8 | 10.09 | 6.08 | 61.9 | 10.09 | 6.10 | 62.1 | 10.09 | 6.11 | 62.2 | 10.09 | 6.13 | 62.4 | 10.09 | 6.14 | 62.5 | 10.09 | 6.16 | 62.7 | 10.09 | 6.17 | 62.8 | 10.09 | 6.19 | 63.0 | 10.09 | 6.20 | 63.1 | 10.09 | 6.22 |
| 14.90 | 61.8 | 10.11 | 6.07 | 61.9 | 10.11 | 6.09 | 62.1 | 10.11 | 6.10 | 62.2 | 10.11 | 6.12 | 62.4 | 10.11 | 6.13 | 62.5 | 10.11 | 6.15 | 62.7 | 10.11 | 6.16 | 62.9 | 10.11 | 6.18 | 63.0 | 10.11 | 6.19 | 63.2 | 10.11 | 6.21 |
| 15.00 | 61.8 | 10.12 | 6.06 | 62.0 | 10.12 | 6.08 | 62.1 | 10.12 | 6.09 | 62.3 | 10.12 | 6.11 | 62.4 | 10.12 | 6.12 | 62.6 | 10.12 | 6.14 | 62.7 | 10.12 | 6.15 | 62.9 | 10.12 | 6.17 | 63.0 | 10.12 | 6.18 | 63.2 | 10.12 | 6.20 |
| 15.10 | 61.8 | 10.13 | 6.05 | 62.0 | 10.13 | 6.07 | 62.1 | 10.13 | 6.08 | 62.3 | 10.13 | 6.10 | 62.4 | 10.13 | 6.11 | 62.6 | 10.13 | 6.13 | 62.7 | 10.13 | 6.14 | 62.9 | 10.13 | 6.16 | 63.0 | 10.13 | 6.18 | 63.2 | 10.13 | 6.19 |
| 15.20 | 61.9 | 10.14 | 6.04 | 62.0 | 10.14 | 6.06 | 62.2 | 10.14 | 6.07 | 62.3 | 10.14 | 6.09 | 62.5 | 10.14 | 6.10 | 62.6 | 10.14 | 6.12 | 62.8 | 10.14 | 6.14 | 62.9 | 10.14 | 6.15 | 63.1 | 10.14 | 6.17 | 63.2 | 10.14 | 6.18 |
| 15.30 | 61.9 | 10.15 | 6.03 | 62.0 | 10.15 | 6.05 | 62.2 | 10.15 | 6.06 | 62.3 | 10.15 | 6.08 | 62.5 | 10.15 | 6.10 | 62.6 | 10.15 | 6.11 | 62.8 | 10.15 | 6.13 | 62.9 | 10.15 | 6.14 | 63.1 | 10.15 | 6.16 | 63.2 | 10.15 | 6.17 |
| 15.40 | 61.9 | 10.17 | 6.02 | 62.1 | 10.17 | 6.04 | 62.2 | 10.17 | 6.05 | 62.4 | 10.17 | 6.07 | 62.5 | 10.17 | 6.09 | 62.7 | 10.17 | 6.10 | 62.8 | 10.17 | 6.12 | 63.0 | 10.17 | 6.13 | 63.1 | 10.17 | 6.15 | 63.3 | 10.17 | 6.16 |
| 15.50 | 61.9 | 10.18 | 6.01 | 62.1 | 10.18 | 6.03 | 62.2 | 10.18 | 6.04 | 62.4 | 10.18 | 6.06 | 62.5 | 10.18 | 6.08 | 62.7 | 10.18 | 6.09 | 62.8 | 10.18 | 6.11 | 63.0 | 10.18 | 6.12 | 63.1 | 10.18 | 6.14 | 63.3 | 10.18 | 6.15 |
| 15.60 | 61.9 | 10.19 | 6.00 | 62.1 | 10.19 | 6.02 | 62.2 | 10.19 | 6.04 | 62.4 | 10.19 | 6.05 | 62.6 | 10.19 | 6.07 | 62.7 | 10.19 | 6.08 | 62.9 | 10.19 | 6.10 | 63.0 | 10.19 | 6.11 | 63.2 | 10.19 | 6.13 | 63.3 | 10.19 | 6.14 |
| 15.70 | 62.0 | 10.20 | 5.99 | 62.1 | 10.20 | 6.01 | 62.3 | 10.20 | 6.03 | 62.4 | 10.20 | 6.04 | 62.6 | 10.20 | 6.06 | 62.7 | 10.20 | 6.07 | 62.9 | 10.20 | 6.09 | 63.0 | 10.20 | 6.10 | 63.2 | 10.20 | 6.12 | 63.3 | 10.20 | 6.13 |
| 15.80 | 62.0 | 10.21 | 5.98 | 62.1 | 10.21 | 6.00 | 62.3 | 10.21 | 6.02 | 62.4 | 10.21 | 6.03 | 62.6 | 10.21 | 6.05 | 62.8 | 10.21 | 6.06 | 62.9 | 10.21 | 6.08 | 63.1 | 10.21 | 6.09 | 63.2 | 10.21 | 6.11 | 63.4 | 10.21 | 6.12 |
| 15.90 | 62.0 | 10.23 | 5.97 | 62.2 | 10.23 | 5.99 | 62.3 | 10.23 | 6.01 | 62.5 | 10.23 | 6.02 | 62.6 | 10.23 | 6.04 | 62.8 | 10.23 | 6.05 | 62.9 | 10.23 | 6.07 | 63.1 | 10.23 | 6.08 | 63.2 | 10.23 | 6.10 | 63.4 | 10.23 | 6.11 |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 10.0; Water (ml) = (% Absorption x 10.0 / 100) + (10.0 - sample weight)

## 10-gram Mixograph: Absorption, Flour and Water Amount Table
## (13.0 - 13.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 13.00 | | | 13.10 | | | 13.20 | | | 13.30 | | | 13.40 | | | 13.50 | | | 13.60 | | | 13.70 | | | 13.80 | | | 13.90 | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml |
| 9.00 | 62.0 | 9.45 | 6.75 | 62.2 | 9.45 | 6.77 | 62.3 | 9.45 | 6.78 | 62.5 | 9.45 | 6.79 | 62.6 | 9.45 | 6.81 | 62.7 | 9.45 | 6.82 | 62.9 | 9.45 | 6.84 | 63.0 | 9.45 | 6.85 | 63.2 | 9.45 | 6.87 | 63.3 | 9.45 | 6.88 |
| 9.10 | 62.0 | 9.46 | 6.74 | 62.2 | 9.46 | 6.76 | 62.3 | 9.46 | 6.77 | 62.5 | 9.46 | 6.79 | 62.6 | 9.46 | 6.80 | 62.8 | 9.46 | 6.81 | 62.9 | 9.46 | 6.83 | 63.0 | 9.46 | 6.84 | 63.2 | 9.46 | 6.86 | 63.3 | 9.46 | 6.87 |
| 9.20 | 62.1 | 9.47 | 6.74 | 62.2 | 9.47 | 6.75 | 62.4 | 9.47 | 6.76 | 62.5 | 9.47 | 6.78 | 62.6 | 9.47 | 6.79 | 62.8 | 9.47 | 6.81 | 62.9 | 9.47 | 6.82 | 63.1 | 9.47 | 6.84 | 63.2 | 9.47 | 6.85 | 63.3 | 9.47 | 6.86 |
| 9.30 | 62.1 | 9.48 | 6.73 | 62.2 | 9.48 | 6.74 | 62.4 | 9.48 | 6.76 | 62.5 | 9.48 | 6.77 | 62.7 | 9.48 | 6.78 | 62.8 | 9.48 | 6.80 | 62.9 | 9.48 | 6.81 | 63.1 | 9.48 | 6.83 | 63.2 | 9.48 | 6.84 | 63.4 | 9.48 | 6.86 |
| 9.40 | 62.1 | 9.49 | 6.72 | 62.3 | 9.49 | 6.73 | 62.4 | 9.49 | 6.75 | 62.5 | 9.49 | 6.76 | 62.7 | 9.49 | 6.78 | 62.8 | 9.49 | 6.79 | 63.0 | 9.49 | 6.80 | 63.1 | 9.49 | 6.82 | 63.2 | 9.49 | 6.83 | 63.4 | 9.49 | 6.85 |
| 9.50 | 62.1 | 9.50 | 6.71 | 62.3 | 9.50 | 6.72 | 62.4 | 9.50 | 6.74 | 62.6 | 9.50 | 6.75 | 62.7 | 9.50 | 6.77 | 62.8 | 9.50 | 6.78 | 63.0 | 9.50 | 6.80 | 63.1 | 9.50 | 6.81 | 63.3 | 9.50 | 6.82 | 63.4 | 9.50 | 6.84 |
| 9.60 | 62.2 | 9.51 | 6.70 | 62.3 | 9.51 | 6.72 | 62.4 | 9.51 | 6.73 | 62.6 | 9.51 | 6.74 | 62.7 | 9.51 | 6.76 | 62.9 | 9.51 | 6.77 | 63.0 | 9.51 | 6.79 | 63.1 | 9.51 | 6.80 | 63.3 | 9.51 | 6.82 | 63.4 | 9.51 | 6.83 |
| 9.70 | 62.2 | 9.52 | 6.69 | 62.3 | 9.52 | 6.71 | 62.5 | 9.52 | 6.72 | 62.6 | 9.52 | 6.74 | 62.7 | 9.52 | 6.75 | 62.9 | 9.52 | 6.76 | 63.0 | 9.52 | 6.78 | 63.2 | 9.52 | 6.79 | 63.3 | 9.52 | 6.81 | 63.5 | 9.52 | 6.82 |
| 9.80 | 62.2 | 9.53 | 6.68 | 62.3 | 9.53 | 6.70 | 62.5 | 9.53 | 6.71 | 62.6 | 9.53 | 6.73 | 62.8 | 9.53 | 6.74 | 62.9 | 9.53 | 6.76 | 63.1 | 9.53 | 6.77 | 63.2 | 9.53 | 6.78 | 63.3 | 9.53 | 6.80 | 63.5 | 9.53 | 6.81 |
| 9.90 | 62.2 | 9.54 | 6.68 | 62.4 | 9.54 | 6.69 | 62.5 | 9.54 | 6.70 | 62.6 | 9.54 | 6.72 | 62.8 | 9.54 | 6.73 | 62.9 | 9.54 | 6.75 | 63.1 | 9.54 | 6.76 | 63.2 | 9.54 | 6.78 | 63.4 | 9.54 | 6.79 | 63.5 | 9.54 | 6.81 |
| 10.00 | 62.2 | 9.56 | 6.67 | 62.4 | 9.56 | 6.68 | 62.5 | 9.56 | 6.70 | 62.7 | 9.56 | 6.71 | 62.8 | 9.56 | 6.73 | 63.0 | 9.56 | 6.74 | 63.1 | 9.56 | 6.75 | 63.2 | 9.56 | 6.77 | 63.4 | 9.56 | 6.78 | 63.5 | 9.56 | 6.80 |
| 10.10 | 62.3 | 9.57 | 6.66 | 62.4 | 9.57 | 6.67 | 62.5 | 9.57 | 6.69 | 62.7 | 9.57 | 6.70 | 62.8 | 9.57 | 6.72 | 63.0 | 9.57 | 6.73 | 63.1 | 9.57 | 6.75 | 63.3 | 9.57 | 6.76 | 63.4 | 9.57 | 6.77 | 63.5 | 9.57 | 6.79 |
| 10.20 | 62.3 | 9.58 | 6.65 | 62.4 | 9.58 | 6.67 | 62.6 | 9.58 | 6.68 | 62.7 | 9.58 | 6.69 | 62.8 | 9.58 | 6.71 | 63.0 | 9.58 | 6.72 | 63.1 | 9.58 | 6.74 | 63.3 | 9.58 | 6.75 | 63.4 | 9.58 | 6.77 | 63.6 | 9.58 | 6.78 |
| 10.30 | 62.3 | 9.59 | 6.64 | 62.4 | 9.59 | 6.66 | 62.6 | 9.59 | 6.67 | 62.7 | 9.59 | 6.69 | 62.9 | 9.59 | 6.70 | 63.0 | 9.59 | 6.71 | 63.2 | 9.59 | 6.73 | 63.3 | 9.59 | 6.74 | 63.4 | 9.59 | 6.76 | 63.6 | 9.59 | 6.77 |
| 10.40 | 62.3 | 9.60 | 6.63 | 62.5 | 9.60 | 6.65 | 62.6 | 9.60 | 6.66 | 62.7 | 9.60 | 6.68 | 62.9 | 9.60 | 6.69 | 63.0 | 9.60 | 6.71 | 63.2 | 9.60 | 6.72 | 63.3 | 9.60 | 6.73 | 63.5 | 9.60 | 6.75 | 63.6 | 9.60 | 6.76 |
| 10.50 | 62.3 | 9.61 | 6.62 | 62.5 | 9.61 | 6.64 | 62.6 | 9.61 | 6.65 | 62.8 | 9.61 | 6.67 | 62.9 | 9.61 | 6.68 | 63.1 | 9.61 | 6.70 | 63.2 | 9.61 | 6.71 | 63.3 | 9.61 | 6.73 | 63.5 | 9.61 | 6.74 | 63.6 | 9.61 | 6.75 |
| 10.60 | 62.4 | 9.62 | 6.62 | 62.5 | 9.62 | 6.63 | 62.6 | 9.62 | 6.65 | 62.8 | 9.62 | 6.66 | 62.9 | 9.62 | 6.67 | 63.1 | 9.62 | 6.69 | 63.2 | 9.62 | 6.70 | 63.4 | 9.62 | 6.72 | 63.5 | 9.62 | 6.73 | 63.7 | 9.62 | 6.75 |
| 10.70 | 62.4 | 9.63 | 6.61 | 62.5 | 9.63 | 6.62 | 62.7 | 9.63 | 6.64 | 62.8 | 9.63 | 6.65 | 63.0 | 9.63 | 6.67 | 63.1 | 9.63 | 6.68 | 63.2 | 9.63 | 6.69 | 63.4 | 9.63 | 6.71 | 63.5 | 9.63 | 6.72 | 63.7 | 9.63 | 6.74 |
| 10.80 | 62.4 | 9.64 | 6.60 | 62.5 | 9.64 | 6.61 | 62.7 | 9.64 | 6.63 | 62.8 | 9.64 | 6.64 | 63.0 | 9.64 | 6.66 | 63.1 | 9.64 | 6.67 | 63.3 | 9.64 | 6.69 | 63.4 | 9.64 | 6.70 | 63.6 | 9.64 | 6.71 | 63.7 | 9.64 | 6.73 |
| 10.90 | 62.4 | 9.65 | 6.59 | 62.6 | 9.65 | 6.60 | 62.7 | 9.65 | 6.62 | 62.9 | 9.65 | 6.63 | 63.0 | 9.65 | 6.65 | 63.1 | 9.65 | 6.66 | 63.3 | 9.65 | 6.68 | 63.4 | 9.65 | 6.69 | 63.6 | 9.65 | 6.71 | 63.7 | 9.65 | 6.72 |
| 11.00 | 62.4 | 9.66 | 6.58 | 62.6 | 9.66 | 6.60 | 62.7 | 9.66 | 6.61 | 62.9 | 9.66 | 6.62 | 63.0 | 9.66 | 6.64 | 63.2 | 9.66 | 6.65 | 63.3 | 9.66 | 6.67 | 63.5 | 9.66 | 6.68 | 63.6 | 9.66 | 6.70 | 63.7 | 9.66 | 6.71 |
| 11.10 | 62.5 | 9.67 | 6.57 | 62.6 | 9.67 | 6.59 | 62.8 | 9.67 | 6.60 | 62.9 | 9.67 | 6.62 | 63.0 | 9.67 | 6.63 | 63.2 | 9.67 | 6.65 | 63.3 | 9.67 | 6.66 | 63.5 | 9.67 | 6.67 | 63.6 | 9.67 | 6.69 | 63.8 | 9.67 | 6.70 |
| 11.20 | 62.5 | 9.68 | 6.56 | 62.6 | 9.68 | 6.58 | 62.8 | 9.68 | 6.59 | 62.9 | 9.68 | 6.61 | 63.1 | 9.68 | 6.62 | 63.2 | 9.68 | 6.64 | 63.4 | 9.68 | 6.65 | 63.5 | 9.68 | 6.67 | 63.6 | 9.68 | 6.68 | 63.8 | 9.68 | 6.69 |
| 11.30 | 62.5 | 9.70 | 6.56 | 62.7 | 9.70 | 6.57 | 62.8 | 9.70 | 6.58 | 62.9 | 9.70 | 6.60 | 63.1 | 9.70 | 6.61 | 63.2 | 9.70 | 6.63 | 63.4 | 9.70 | 6.64 | 63.5 | 9.70 | 6.66 | 63.7 | 9.70 | 6.67 | 63.8 | 9.70 | 6.69 |
| 11.40 | 62.5 | 9.71 | 6.55 | 62.7 | 9.71 | 6.56 | 62.8 | 9.71 | 6.58 | 63.0 | 9.71 | 6.59 | 63.1 | 9.71 | 6.60 | 63.3 | 9.71 | 6.62 | 63.4 | 9.71 | 6.63 | 63.5 | 9.71 | 6.65 | 63.7 | 9.71 | 6.66 | 63.8 | 9.71 | 6.68 |
| 11.50 | 62.5 | 9.72 | 6.54 | 62.7 | 9.72 | 6.55 | 62.8 | 9.72 | 6.57 | 63.0 | 9.72 | 6.58 | 63.1 | 9.72 | 6.60 | 63.3 | 9.72 | 6.61 | 63.4 | 9.72 | 6.62 | 63.6 | 9.72 | 6.64 | 63.7 | 9.72 | 6.65 | 63.9 | 9.72 | 6.67 |
| 11.60 | 62.6 | 9.73 | 6.53 | 62.7 | 9.73 | 6.54 | 62.9 | 9.73 | 6.56 | 63.0 | 9.73 | 6.57 | 63.2 | 9.73 | 6.59 | 63.3 | 9.73 | 6.60 | 63.4 | 9.73 | 6.62 | 63.6 | 9.73 | 6.63 | 63.7 | 9.73 | 6.65 | 63.9 | 9.73 | 6.66 |
| 11.70 | 62.6 | 9.74 | 6.52 | 62.7 | 9.74 | 6.53 | 62.9 | 9.74 | 6.55 | 63.0 | 9.74 | 6.56 | 63.2 | 9.74 | 6.58 | 63.3 | 9.74 | 6.59 | 63.5 | 9.74 | 6.61 | 63.6 | 9.74 | 6.62 | 63.8 | 9.74 | 6.64 | 63.9 | 9.74 | 6.65 |
| 11.80 | 62.6 | 9.75 | 6.51 | 62.8 | 9.75 | 6.53 | 62.9 | 9.75 | 6.54 | 63.1 | 9.75 | 6.55 | 63.2 | 9.75 | 6.57 | 63.3 | 9.75 | 6.58 | 63.5 | 9.75 | 6.60 | 63.6 | 9.75 | 6.61 | 63.8 | 9.75 | 6.63 | 63.9 | 9.75 | 6.64 |
| 11.90 | 62.6 | 9.76 | 6.50 | 62.8 | 9.76 | 6.52 | 62.9 | 9.76 | 6.53 | 63.1 | 9.76 | 6.55 | 63.2 | 9.76 | 6.56 | 63.4 | 9.76 | 6.58 | 63.5 | 9.76 | 6.59 | 63.7 | 9.76 | 6.60 | 63.8 | 9.76 | 6.62 | 64.0 | 9.76 | 6.63 |
| 12.00 | 62.7 | 9.77 | 6.49 | 62.8 | 9.77 | 6.51 | 63.0 | 9.77 | 6.52 | 63.1 | 9.77 | 6.54 | 63.2 | 9.77 | 6.55 | 63.4 | 9.77 | 6.57 | 63.5 | 9.77 | 6.58 | 63.7 | 9.77 | 6.60 | 63.8 | 9.77 | 6.61 | 64.0 | 9.77 | 6.62 |
| 12.10 | 62.7 | 9.78 | 6.48 | 62.8 | 9.78 | 6.50 | 63.0 | 9.78 | 6.51 | 63.1 | 9.78 | 6.53 | 63.3 | 9.78 | 6.54 | 63.4 | 9.78 | 6.56 | 63.6 | 9.78 | 6.57 | 63.7 | 9.78 | 6.59 | 63.9 | 9.78 | 6.60 | 64.0 | 9.78 | 6.62 |
| 12.30 | 62.7 | 9.81 | 6.47 | 62.9 | 9.81 | 6.48 | 63.0 | 9.81 | 6.50 | 63.2 | 9.81 | 6.51 | 63.3 | 9.81 | 6.52 | 63.5 | 9.81 | 6.54 | 63.6 | 9.81 | 6.55 | 63.8 | 9.81 | 6.57 | 63.9 | 9.81 | 6.58 | 64.0 | 9.81 | 6.60 |
| 12.30 | 62.7 | 9.81 | 6.47 | 62.9 | 9.81 | 6.48 | 63.0 | 9.81 | 6.50 | 63.2 | 9.81 | 6.51 | 63.3 | 9.81 | 6.52 | 63.5 | 9.81 | 6.54 | 63.6 | 9.81 | 6.55 | 63.8 | 9.81 | 6.57 | 63.9 | 9.81 | 6.58 | 64.0 | 9.81 | 6.60 |
| 12.40 | 62.7 | 9.82 | 6.46 | 62.9 | 9.82 | 6.47 | 63.0 | 9.82 | 6.49 | 63.2 | 9.82 | 6.50 | 63.3 | 9.82 | 6.52 | 63.5 | 9.82 | 6.53 | 63.6 | 9.82 | 6.55 | 63.8 | 9.82 | 6.56 | 63.9 | 9.82 | 6.57 | 64.1 | 9.82 | 6.59 |
| 12.50 | 62.8 | 9.83 | 6.45 | 62.9 | 9.83 | 6.46 | 63.1 | 9.83 | 6.48 | 63.2 | 9.83 | 6.49 | 63.4 | 9.83 | 6.51 | 63.5 | 9.83 | 6.52 | 63.7 | 9.83 | 6.54 | 63.8 | 9.83 | 6.55 | 63.9 | 9.83 | 6.57 | 64.1 | 9.83 | 6.58 |
| 12.60 | 62.8 | 9.84 | 6.44 | 62.9 | 9.84 | 6.45 | 63.1 | 9.84 | 6.47 | 63.2 | 9.84 | 6.48 | 63.4 | 9.84 | 6.50 | 63.5 | 9.84 | 6.51 | 63.7 | 9.84 | 6.53 | 63.8 | 9.84 | 6.54 | 64.0 | 9.84 | 6.56 | 64.1 | 9.84 | 6.57 |
| 12.70 | 62.8 | 9.85 | 6.43 | 63.0 | 9.85 | 6.44 | 63.1 | 9.85 | 6.46 | 63.3 | 9.85 | 6.47 | 63.4 | 9.85 | 6.49 | 63.5 | 9.85 | 6.50 | 63.7 | 9.85 | 6.52 | 63.8 | 9.85 | 6.53 | 64.0 | 9.85 | 6.55 | 64.1 | 9.85 | 6.56 |
| 12.80 | 62.8 | 9.86 | 6.42 | 63.0 | 9.86 | 6.44 | 63.1 | 9.86 | 6.45 | 63.3 | 9.86 | 6.47 | 63.4 | 9.86 | 6.48 | 63.6 | 9.86 | 6.49 | 63.7 | 9.86 | 6.51 | 63.9 | 9.86 | 6.52 | 64.0 | 9.86 | 6.54 | 64.2 | 9.86 | 6.55 |
| 12.90 | 62.9 | 9.87 | 6.41 | 63.0 | 9.87 | 6.43 | 63.1 | 9.87 | 6.44 | 63.3 | 9.87 | 6.46 | 63.4 | 9.87 | 6.47 | 63.6 | 9.87 | 6.49 | 63.7 | 9.87 | 6.50 | 63.9 | 9.87 | 6.52 | 64.0 | 9.87 | 6.53 | 64.2 | 9.87 | 6.54 |
| 13.00 | 62.9 | 9.89 | 6.40 | 63.0 | 9.89 | 6.42 | 63.2 | 9.89 | 6.43 | 63.3 | 9.89 | 6.45 | 63.5 | 9.89 | 6.46 | 63.6 | 9.89 | 6.48 | 63.8 | 9.89 | 6.49 | 63.9 | 9.89 | 6.51 | 64.1 | 9.89 | 6.52 | 64.2 | 9.89 | 6.54 |
| 13.10 | 62.9 | 9.90 | 6.39 | 63.0 | 9.90 | 6.41 | 63.2 | 9.90 | 6.42 | 63.3 | 9.90 | 6.44 | 63.5 | 9.90 | 6.45 | 63.6 | 9.90 | 6.47 | 63.8 | 9.90 | 6.48 | 63.9 | 9.90 | 6.50 | 64.1 | 9.90 | 6.51 | 64.2 | 9.90 | 6.53 |
| 13.20 | 62.9 | 9.91 | 6.38 | 63.1 | 9.91 | 6.40 | 63.2 | 9.91 | 6.41 | 63.4 | 9.91 | 6.43 | 63.5 | 9.91 | 6.44 | 63.7 | 9.91 | 6.46 | 63.8 | 9.91 | 6.47 | 64.0 | 9.91 | 6.49 | 64.1 | 9.91 | 6.50 | 64.3 | 9.91 | 6.52 |
| 13.30 | 62.9 | 9.92 | 6.37 | 63.1 | 9.92 | 6.39 | 63.2 | 9.92 | 6.40 | 63.4 | 9.92 | 6.42 | 63.5 | 9.92 | 6.43 | 63.7 | 9.92 | 6.45 | 63.8 | 9.92 | 6.46 | 64.0 | 9.92 | 6.48 | 64.1 | 9.92 | 6.49 | 64.3 | 9.92 | 6.51 |
| 13.40 | 63.0 | 9.93 | 6.37 | 63.1 | 9.93 | 6.38 | 63.3 | 9.93 | 6.40 | 63.4 | 9.93 | 6.41 | 63.6 | 9.93 | 6.43 | 63.7 | 9.93 | 6.44 | 63.9 | 9.93 | 6.46 | 64.0 | 9.93 | 6.47 | 64.2 | 9.93 | 6.48 | 64.3 | 9.93 | 6.50 |
| 13.50 | 63.0 | 9.94 | 6.36 | 63.1 | 9.94 | 6.37 | 63.3 | 9.94 | 6.39 | 63.4 | 9.94 | 6.40 | 63.6 | 9.94 | 6.42 | 63.7 | 9.94 | 6.43 | 63.9 | 9.94 | 6.45 | 64.0 | 9.94 | 6.46 | 64.2 | 9.94 | 6.48 | 64.3 | 9.94 | 6.49 |
| 13.60 | 63.0 | 9.95 | 6.35 | 63.2 | 9.95 | 6.36 | 63.3 | 9.95 | 6.38 | 63.5 | 9.95 | 6.39 | 63.6 | 9.95 | 6.41 | 63.8 | 9.95 | 6.42 | 63.9 | 9.95 | 6.44 | 64.1 | 9.95 | 6.45 | 64.2 | 9.95 | 6.47 | 64.4 | 9.95 | 6.48 |
| 13.70 | 63.0 | 9.97 | 6.34 | 63.2 | 9.97 | 6.35 | 63.3 | 9.97 | 6.37 | 63.5 | 9.97 | 6.38 | 63.6 | 9.97 | 6.40 | 63.8 | 9.97 | 6.41 | 63.9 | 9.97 | 6.43 | 64.1 | 9.97 | 6.44 | 64.2 | 9.97 | 6.46 | 64.4 | 9.97 | 6.47 |
| 13.80 | 63.1 | 9.98 | 6.33 | 63.2 | 9.98 | 6.34 | 63.4 | 9.98 | 6.36 | 63.5 | 9.98 | 6.37 | 63.7 | 9.98 | 6.39 | 63.8 | 9.98 | 6.40 | 64.0 | 9.98 | 6.42 | 64.1 | 9.98 | 6.43 | 64.3 | 9.98 | 6.45 | 64.4 | 9.98 | 6.46 |
| 13.90 | 63.1 | 9.99 | 6.32 | 63.2 | 9.99 | 6.33 | 63.4 | 9.99 | 6.35 | 63.5 | 9.99 | 6.36 | 63.7 | 9.99 | 6.38 | 63.8 | 9.99 | 6.39 | 64.0 | 9.99 | 6.41 | 64.1 | 9.99 | 6.42 | 64.3 | 9.99 | 6.44 | 64.4 | 9.99 | 6.45 |
| 14.00 | 63.1 | 10.00 | 6.31 | 63.3 | 10.00 | 6.33 | 63.4 | 10.00 | 6.34 | 63.6 | 10.00 | 6.36 | 63.7 | 10.00 | 6.37 | 63.9 | 10.00 | 6.39 | 64.0 | 10.00 | 6.40 | 64.2 | 10.00 | 6.42 | 64.3 | 10.00 | 6.43 | 64.5 | 10.00 | 6.45 |
| 14.10 | 63.1 | 10.01 | 6.30 | 63.3 | 10.01 | 6.32 | 63.4 | 10.01 | 6.33 | 63.6 | 10.01 | 6.35 | 63.7 | 10.01 | 6.36 | 63.9 | 10.01 | 6.38 | 64.0 | 10.01 | 6.39 | 64.2 | 10.01 | 6.41 | 64.3 | 10.01 | 6.42 | 64.5 | 10.01 | 6.44 |
| 14.20 | 63.1 | 10.02 | 6.29 | 63.3 | 10.02 | 6.31 | 63.4 | 10.02 | 6.32 | 63.6 | 10.02 | 6.34 | 63.7 | 10.02 | 6.35 | 63.9 | 10.02 | 6.37 | 64.0 | 10.02 | 6.38 | 64.2 | 10.02 | 6.40 | 64.3 | 10.02 | 6.41 | 64.5 | 10.02 | 6.43 |
| 14.30 | 63.2 | 10.04 | 6.28 | 63.3 | 10.04 | 6.30 | 63.5 | 10.04 | 6.31 | 63.6 | 10.04 | 6.33 | 63.8 | 10.04 | 6.34 | 63.9 | 10.04 | 6.36 | 64.1 | 10.04 | 6.37 | 64.2 | 10.04 | 6.39 | 64.4 | 10.04 | 6.40 | 64.5 | 10.04 | 6.42 |
| 14.40 | 63.2 | 10.05 | 6.27 | 63.3 | 10.05 | 6.29 | 63.5 | 10.05 | 6.30 | 63.6 | 10.05 | 6.32 | 63.8 | 10.05 | 6.33 | 63.9 | 10.05 | 6.35 | 64.1 | 10.05 | 6.36 | 64.2 | 10.05 | 6.38 | 64.4 | 10.05 | 6.39 | 64.5 | 10.05 | 6.41 |
| 14.50 | 63.2 | 10.06 | 6.26 | 63.4 | 10.06 | 6.28 | 63.5 | 10.06 | 6.29 | 63.7 | 10.06 | 6.31 | 63.8 | 10.06 | 6.32 | 64.0 | 10.06 | 6.34 | 64.1 | 10.06 | 6.35 | 64.3 | 10.06 | 6.37 | 64.4 | 10.06 | 6.38 | 64.6 | 10.06 | 6.40 |
| 14.60 | 63.2 | 10.07 | 6.25 | 63.4 | 10.07 | 6.27 | 63.5 | 10.07 | 6.28 | 63.7 | 10.07 | 6.30 | 63.8 | 10.07 | 6.31 | 64.0 | 10.07 | 6.33 | 64.1 | 10.07 | 6.34 | 64.3 | 10.07 | 6.36 | 64.4 | 10.07 | 6.37 | 64.6 | 10.07 | 6.39 |
| 14.70 | 63.3 | 10.08 | 6.24 | 63.4 | 10.08 | 6.26 | 63.6 | 10.08 | 6.27 | 63.7 | 10.08 | 6.29 | 63.9 | 10.08 | 6.30 | 64.0 | 10.08 | 6.32 | 64.2 | 10.08 | 6.33 | 64.3 | 10.08 | 6.35 | 64.5 | 10.08 | 6.36 | 64.6 | 10.08 | 6.38 |
| 14.80 | 63.3 | 10.09 | 6.23 | 63.4 | 10.09 | 6.25 | 63.6 | 10.09 | 6.26 | 63.7 | 10.09 | 6.28 | 63.9 | 10.09 | 6.29 | 64.0 | 10.09 | 6.31 | 64.2 | 10.09 | 6.33 | 64.3 | 10.09 | 6.34 | 64.5 | 10.09 | 6.36 | 64.6 | 10.09 | 6.37 |
| 14.90 | 63.3 | 10.11 | 6.22 | 63.5 | 10.11 | 6.24 | 63.6 | 10.11 | 6.26 | 63.8 | 10.11 | 6.27 | 63.9 | 10.11 | 6.29 | 64.1 | 10.11 | 6.30 | 64.2 | 10.11 | 6.32 | 64.4 | 10.11 | 6.33 | 64.5 | 10.11 | 6.35 | 64.7 | 10.11 | 6.36 |
| 15.00 | 63.3 | 10.12 | 6.22 | 63.5 | 10.12 | 6.23 | 63.6 | 10.12 | 6.25 | 63.8 | 10.12 | 6.26 | 63.9 | 10.12 | 6.28 | 64.1 | 10.12 | 6.29 | 64.2 | 10.12 | 6.31 | 64.4 | 10.12 | 6.32 | 64.5 | 10.12 | 6.34 | 64.7 | 10.12 | 6.35 |
| 15.10 | 63.4 | 10.13 | 6.21 | 63.5 | 10.13 | 6.22 | 63.7 | 10.13 | 6.24 | 63.8 | 10.13 | 6.25 | 64.0 | 10.13 | 6.27 | 64.1 | 10.13 | 6.28 | 64.3 | 10.13 | 6.30 | 64.4 | 10.13 | 6.31 | 64.6 | 10.13 | 6.33 | 64.7 | 10.13 | 6.34 |
| 15.20 | 63.4 | 10.14 | 6.20 | 63.5 | 10.14 | 6.21 | 63.7 | 10.14 | 6.23 | 63.8 | 10.14 | 6.24 | 64.0 | 10.14 | 6.26 | 64.1 | 10.14 | 6.27 | 64.3 | 10.14 | 6.29 | 64.4 | 10.14 | 6.30 | 64.6 | 10.14 | 6.32 | 64.7 | 10.14 | 6.33 |
| 15.30 | 63.4 | 10.15 | 6.19 | 63.6 | 10.15 | 6.20 | 63.7 | 10.15 | 6.22 | 63.9 | 10.15 | 6.23 | 64.0 | 10.15 | 6.25 | 64.2 | 10.15 | 6.26 | 64.3 | 10.15 | 6.28 | 64.5 | 10.15 | 6.29 | 64.6 | 10.15 | 6.31 | 64.8 | 10.15 | 6.32 |
| 15.40 | 63.4 | 10.17 | 6.18 | 63.6 | 10.17 | 6.19 | 63.7 | 10.17 | 6.21 | 63.9 | 10.17 | 6.22 | 64.0 | 10.17 | 6.24 | 64.2 | 10.17 | 6.25 | 64.3 | 10.17 | 6.27 | 64.5 | 10.17 | 6.28 | 64.6 | 10.17 | 6.30 | 64.8 | 10.17 | 6.31 |
| 15.50 | 63.4 | 10.18 | 6.17 | 63.6 | 10.18 | 6.18 | 63.8 | 10.18 | 6.20 | 63.9 | 10.18 | 6.21 | 64.1 | 10.18 | 6.23 | 64.2 | 10.18 | 6.24 | 64.4 | 10.18 | 6.26 | 64.5 | 10.18 | 6.27 | 64.7 | 10.18 | 6.29 | 64.8 | 10.18 | 6.30 |
| 15.60 | 63.5 | 10.19 | 6.16 | 63.6 | 10.19 | 6.17 | 63.8 | 10.19 | 6.19 | 63.9 | 10.19 | 6.20 | 64.1 | 10.19 | 6.22 | 64.2 | 10.19 | 6.23 | 64.4 | 10.19 | 6.25 | 64.5 | 10.19 | 6.26 | 64.7 | 10.19 | 6.28 | 64.8 | 10.19 | 6.29 |
| 15.70 | 63.5 | 10.20 | 6.15 | 63.6 | 10.20 | 6.16 | 63.8 | 10.20 | 6.18 | 64.0 | 10.20 | 6.19 | 64.1 | 10.20 | 6.21 | 64.3 | 10.20 | 6.22 | 64.4 | 10.20 | 6.24 | 64.6 | 10.20 | 6.25 | 64.7 | 10.20 | 6.27 | 64.9 | 10.20 | 6.29 |
| 15.80 | 63.5 | 10.21 | 6.14 | 63.7 | 10.21 | 6.15 | 63.8 | 10.21 | 6.17 | 64.0 | 10.21 | 6.18 | 64.1 | 10.21 | 6.20 | 64.3 | 10.21 | 6.21 | 64.4 | 10.21 | 6.23 | 64.6 | 10.21 | 6.25 | 64.7 | 10.21 | 6.26 | 64.9 | 10.21 | 6.28 |
| 15.90 | 63.5 | 10.23 | 6.13 | 63.7 | 10.23 | 6.14 | 63.8 | 10.23 | 6.16 | 64.0 | 10.23 | 6.17 | 64.2 | 10.23 | 6.19 | 64.3 | 10.23 | 6.20 | 64.5 | 10.23 | 6.22 | 64.6 | 10.23 | 6.24 | 64.8 | 10.23 | 6.25 | 64.9 | 10.23 | 6.27 |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 10.0; Water (ml) = (% Absorption x 10.0 / 100) + (10.0 - sample weight)

## 10-gram Mixograph: Absorption, Flour and Water Amount Table
## (14.0 - 14.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 14.00 | | | 14.10 | | | 14.20 | | | 14.30 | | | 14.40 | | | 14.50 | | | 14.60 | | | 14.70 | | | 14.80 | | | 14.90 | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml |
| 9.00 | 63.4 | 9.45 | 6.89 | 63.6 | 9.45 | 6.91 | 63.7 | 9.45 | 6.92 | 63.9 | 9.45 | 6.94 | 64.0 | 9.45 | 6.95 | 64.2 | 9.45 | 6.96 | 64.3 | 9.45 | 6.98 | 64.4 | 9.45 | 6.99 | 64.6 | 9.45 | 7.01 | 64.7 | 9.45 | 7.02 |
| 9.10 | 63.5 | 9.46 | 6.89 | 63.6 | 9.46 | 6.90 | 63.8 | 9.46 | 6.91 | 63.9 | 9.46 | 6.93 | 64.0 | 9.46 | 6.94 | 64.2 | 9.46 | 6.96 | 64.3 | 9.46 | 6.97 | 64.5 | 9.46 | 6.99 | 64.6 | 9.46 | 7.00 | 64.7 | 9.46 | 7.01 |
| 9.20 | 63.5 | 9.47 | 6.88 | 63.6 | 9.47 | 6.89 | 63.8 | 9.47 | 6.91 | 63.9 | 9.47 | 6.92 | 64.1 | 9.47 | 6.93 | 64.2 | 9.47 | 6.95 | 64.3 | 9.47 | 6.96 | 64.5 | 9.47 | 6.98 | 64.6 | 9.47 | 6.99 | 64.8 | 9.47 | 7.01 |
| 9.30 | 63.5 | 9.48 | 6.87 | 63.7 | 9.48 | 6.88 | 63.8 | 9.48 | 6.90 | 63.9 | 9.48 | 6.91 | 64.1 | 9.48 | 6.93 | 64.2 | 9.48 | 6.94 | 64.4 | 9.48 | 6.95 | 64.5 | 9.48 | 6.97 | 64.6 | 9.48 | 6.98 | 64.8 | 9.48 | 7.00 |
| 9.40 | 63.5 | 9.49 | 6.86 | 63.7 | 9.49 | 6.88 | 63.8 | 9.49 | 6.89 | 64.0 | 9.49 | 6.90 | 64.1 | 9.49 | 6.92 | 64.2 | 9.49 | 6.93 | 64.4 | 9.49 | 6.95 | 64.5 | 9.49 | 6.96 | 64.7 | 9.49 | 6.98 | 64.8 | 9.49 | 6.99 |
| 9.50 | 63.6 | 9.50 | 6.85 | 63.7 | 9.50 | 6.87 | 63.8 | 9.50 | 6.88 | 64.0 | 9.50 | 6.90 | 64.1 | 9.50 | 6.91 | 64.3 | 9.50 | 6.92 | 64.4 | 9.50 | 6.94 | 64.6 | 9.50 | 6.95 | 64.7 | 9.50 | 6.97 | 64.8 | 9.50 | 6.98 |
| 9.60 | 63.6 | 9.51 | 6.84 | 63.7 | 9.51 | 6.86 | 63.9 | 9.51 | 6.87 | 64.0 | 9.51 | 6.89 | 64.1 | 9.51 | 6.90 | 64.3 | 9.51 | 6.92 | 64.4 | 9.51 | 6.93 | 64.6 | 9.51 | 6.94 | 64.7 | 9.51 | 6.96 | 64.9 | 9.51 | 6.97 |
| 9.70 | 63.6 | 9.52 | 6.84 | 63.7 | 9.52 | 6.85 | 63.9 | 9.52 | 6.86 | 64.0 | 9.52 | 6.88 | 64.2 | 9.52 | 6.89 | 64.3 | 9.52 | 6.91 | 64.5 | 9.52 | 6.92 | 64.6 | 9.52 | 6.94 | 64.7 | 9.52 | 6.95 | 64.9 | 9.52 | 6.96 |
| 9.80 | 63.6 | 9.53 | 6.83 | 63.8 | 9.53 | 6.84 | 63.9 | 9.53 | 6.86 | 64.1 | 9.53 | 6.87 | 64.2 | 9.53 | 6.89 | 64.3 | 9.53 | 6.90 | 64.5 | 9.53 | 6.91 | 64.6 | 9.53 | 6.93 | 64.8 | 9.53 | 6.94 | 64.9 | 9.53 | 6.96 |
| 9.90 | 63.6 | 9.54 | 6.82 | 63.8 | 9.54 | 6.83 | 63.9 | 9.54 | 6.85 | 64.1 | 9.54 | 6.86 | 64.2 | 9.54 | 6.88 | 64.4 | 9.54 | 6.89 | 64.5 | 9.54 | 6.91 | 64.6 | 9.54 | 6.92 | 64.8 | 9.54 | 6.93 | 64.9 | 9.54 | 6.95 |
| 10.00 | 63.7 | 9.56 | 6.81 | 63.8 | 9.56 | 6.83 | 64.0 | 9.56 | 6.84 | 64.1 | 9.56 | 6.85 | 64.2 | 9.56 | 6.87 | 64.4 | 9.56 | 6.88 | 64.5 | 9.56 | 6.90 | 64.7 | 9.56 | 6.91 | 64.8 | 9.56 | 6.93 | 65.0 | 9.56 | 6.94 |
| 10.10 | 63.7 | 9.57 | 6.80 | 63.8 | 9.57 | 6.82 | 64.0 | 9.57 | 6.83 | 64.1 | 9.57 | 6.85 | 64.3 | 9.57 | 6.86 | 64.4 | 9.57 | 6.87 | 64.5 | 9.57 | 6.89 | 64.7 | 9.57 | 6.90 | 64.8 | 9.57 | 6.92 | 65.0 | 9.57 | 6.93 |
| 10.20 | 63.7 | 9.58 | 6.79 | 63.9 | 9.58 | 6.81 | 64.0 | 9.58 | 6.82 | 64.1 | 9.58 | 6.84 | 64.3 | 9.58 | 6.85 | 64.4 | 9.58 | 6.87 | 64.6 | 9.58 | 6.88 | 64.7 | 9.58 | 6.89 | 64.9 | 9.58 | 6.91 | 65.0 | 9.58 | 6.92 |
| 10.30 | 63.7 | 9.59 | 6.79 | 63.9 | 9.59 | 6.80 | 64.0 | 9.59 | 6.81 | 64.2 | 9.59 | 6.83 | 64.3 | 9.59 | 6.84 | 64.5 | 9.59 | 6.86 | 64.6 | 9.59 | 6.87 | 64.7 | 9.59 | 6.89 | 64.9 | 9.59 | 6.90 | 65.0 | 9.59 | 6.92 |
| 10.40 | 63.8 | 9.60 | 6.78 | 63.9 | 9.60 | 6.79 | 64.0 | 9.60 | 6.81 | 64.2 | 9.60 | 6.82 | 64.3 | 9.60 | 6.84 | 64.5 | 9.60 | 6.85 | 64.6 | 9.60 | 6.86 | 64.8 | 9.60 | 6.88 | 64.9 | 9.60 | 6.89 | 65.1 | 9.60 | 6.91 |
| 10.50 | 63.8 | 9.61 | 6.77 | 63.9 | 9.61 | 6.78 | 64.1 | 9.61 | 6.80 | 64.2 | 9.61 | 6.81 | 64.4 | 9.61 | 6.83 | 64.5 | 9.61 | 6.84 | 64.6 | 9.61 | 6.86 | 64.8 | 9.61 | 6.87 | 64.9 | 9.61 | 6.88 | 65.1 | 9.61 | 6.90 |
| 10.60 | 63.8 | 9.62 | 6.76 | 63.9 | 9.62 | 6.77 | 64.1 | 9.62 | 6.79 | 64.2 | 9.62 | 6.80 | 64.4 | 9.62 | 6.82 | 64.5 | 9.62 | 6.83 | 64.7 | 9.62 | 6.85 | 64.8 | 9.62 | 6.86 | 65.0 | 9.62 | 6.88 | 65.1 | 9.62 | 6.89 |
| 10.70 | 63.8 | 9.63 | 6.75 | 64.0 | 9.63 | 6.77 | 64.1 | 9.63 | 6.78 | 64.3 | 9.63 | 6.80 | 64.4 | 9.63 | 6.81 | 64.5 | 9.63 | 6.82 | 64.7 | 9.63 | 6.84 | 64.8 | 9.63 | 6.85 | 65.0 | 9.63 | 6.87 | 65.1 | 9.63 | 6.88 |
| 10.80 | 63.8 | 9.64 | 6.74 | 64.0 | 9.64 | 6.76 | 64.1 | 9.64 | 6.77 | 64.3 | 9.64 | 6.79 | 64.4 | 9.64 | 6.80 | 64.6 | 9.64 | 6.82 | 64.7 | 9.64 | 6.83 | 64.9 | 9.64 | 6.84 | 65.0 | 9.64 | 6.86 | 65.1 | 9.64 | 6.87 |
| 10.90 | 63.9 | 9.65 | 6.73 | 64.0 | 9.65 | 6.75 | 64.2 | 9.65 | 6.76 | 64.3 | 9.65 | 6.78 | 64.4 | 9.65 | 6.79 | 64.6 | 9.65 | 6.81 | 64.7 | 9.65 | 6.82 | 64.9 | 9.65 | 6.84 | 65.0 | 9.65 | 6.85 | 65.2 | 9.65 | 6.87 |
| 11.00 | 63.9 | 9.66 | 6.73 | 64.0 | 9.66 | 6.74 | 64.2 | 9.66 | 6.76 | 64.3 | 9.66 | 6.77 | 64.5 | 9.66 | 6.78 | 64.6 | 9.66 | 6.80 | 64.8 | 9.66 | 6.81 | 64.9 | 9.66 | 6.83 | 65.1 | 9.66 | 6.84 | 65.2 | 9.66 | 6.86 |
| 11.10 | 63.9 | 9.67 | 6.72 | 64.1 | 9.67 | 6.73 | 64.2 | 9.67 | 6.75 | 64.4 | 9.67 | 6.76 | 64.5 | 9.67 | 6.78 | 64.6 | 9.67 | 6.79 | 64.8 | 9.67 | 6.80 | 64.9 | 9.67 | 6.82 | 65.1 | 9.67 | 6.83 | 65.2 | 9.67 | 6.85 |
| 11.20 | 63.9 | 9.68 | 6.71 | 64.1 | 9.68 | 6.72 | 64.2 | 9.68 | 6.74 | 64.4 | 9.68 | 6.75 | 64.5 | 9.68 | 6.77 | 64.7 | 9.68 | 6.78 | 64.8 | 9.68 | 6.80 | 65.0 | 9.68 | 6.81 | 65.1 | 9.68 | 6.83 | 65.2 | 9.68 | 6.84 |
| 11.30 | 64.0 | 9.70 | 6.70 | 64.1 | 9.70 | 6.72 | 64.3 | 9.70 | 6.73 | 64.4 | 9.70 | 6.74 | 64.5 | 9.70 | 6.76 | 64.7 | 9.70 | 6.77 | 64.8 | 9.70 | 6.79 | 65.0 | 9.70 | 6.80 | 65.1 | 9.70 | 6.82 | 65.3 | 9.70 | 6.83 |
| 11.40 | 64.0 | 9.71 | 6.69 | 64.1 | 9.71 | 6.71 | 64.3 | 9.71 | 6.72 | 64.4 | 9.71 | 6.74 | 64.6 | 9.71 | 6.75 | 64.7 | 9.71 | 6.76 | 64.9 | 9.71 | 6.78 | 65.0 | 9.71 | 6.79 | 65.1 | 9.71 | 6.81 | 65.3 | 9.71 | 6.82 |
| 11.50 | 64.0 | 9.72 | 6.68 | 64.2 | 9.72 | 6.70 | 64.3 | 9.72 | 6.71 | 64.4 | 9.72 | 6.73 | 64.6 | 9.72 | 6.74 | 64.7 | 9.72 | 6.76 | 64.9 | 9.72 | 6.77 | 65.0 | 9.72 | 6.79 | 65.2 | 9.72 | 6.80 | 65.3 | 9.72 | 6.81 |
| 11.60 | 64.0 | 9.73 | 6.67 | 64.2 | 9.73 | 6.69 | 64.3 | 9.73 | 6.70 | 64.5 | 9.73 | 6.72 | 64.6 | 9.73 | 6.73 | 64.8 | 9.73 | 6.75 | 64.9 | 9.73 | 6.76 | 65.1 | 9.73 | 6.78 | 65.2 | 9.73 | 6.79 | 65.3 | 9.73 | 6.81 |
| 11.70 | 64.1 | 9.74 | 6.67 | 64.2 | 9.74 | 6.68 | 64.3 | 9.74 | 6.69 | 64.5 | 9.74 | 6.71 | 64.6 | 9.74 | 6.72 | 64.8 | 9.74 | 6.74 | 64.9 | 9.74 | 6.75 | 65.1 | 9.74 | 6.77 | 65.2 | 9.74 | 6.78 | 65.4 | 9.74 | 6.80 |
| 11.80 | 64.1 | 9.75 | 6.66 | 64.2 | 9.75 | 6.67 | 64.4 | 9.75 | 6.69 | 64.5 | 9.75 | 6.70 | 64.7 | 9.75 | 6.72 | 64.8 | 9.75 | 6.73 | 65.0 | 9.75 | 6.74 | 65.1 | 9.75 | 6.76 | 65.2 | 9.75 | 6.77 | 65.4 | 9.75 | 6.79 |
| 11.90 | 64.1 | 9.76 | 6.65 | 64.2 | 9.76 | 6.66 | 64.4 | 9.76 | 6.68 | 64.5 | 9.76 | 6.69 | 64.7 | 9.76 | 6.71 | 64.8 | 9.76 | 6.72 | 65.0 | 9.76 | 6.74 | 65.1 | 9.76 | 6.75 | 65.3 | 9.76 | 6.77 | 65.4 | 9.76 | 6.78 |
| 12.00 | 64.1 | 9.77 | 6.64 | 64.3 | 9.77 | 6.65 | 64.4 | 9.77 | 6.67 | 64.6 | 9.77 | 6.68 | 64.7 | 9.77 | 6.70 | 64.9 | 9.77 | 6.71 | 65.0 | 9.77 | 6.73 | 65.1 | 9.77 | 6.74 | 65.3 | 9.77 | 6.76 | 65.4 | 9.77 | 6.77 |
| 12.10 | 64.1 | 9.78 | 6.63 | 64.3 | 9.78 | 6.65 | 64.4 | 9.78 | 6.66 | 64.6 | 9.78 | 6.67 | 64.7 | 9.78 | 6.69 | 64.9 | 9.78 | 6.70 | 65.0 | 9.78 | 6.72 | 65.2 | 9.78 | 6.73 | 65.3 | 9.78 | 6.75 | 65.5 | 9.78 | 6.76 |
| 12.30 | 64.2 | 9.81 | 6.61 | 64.3 | 9.81 | 6.63 | 64.5 | 9.81 | 6.64 | 64.6 | 9.81 | 6.66 | 64.8 | 9.81 | 6.67 | 64.9 | 9.81 | 6.69 | 65.1 | 9.81 | 6.70 | 65.2 | 9.81 | 6.72 | 65.4 | 9.81 | 6.73 | 65.5 | 9.81 | 6.75 |
| 12.30 | 64.2 | 9.81 | 6.61 | 64.3 | 9.81 | 6.63 | 64.5 | 9.81 | 6.64 | 64.6 | 9.81 | 6.66 | 64.8 | 9.81 | 6.67 | 64.9 | 9.81 | 6.69 | 65.1 | 9.81 | 6.70 | 65.2 | 9.81 | 6.72 | 65.4 | 9.81 | 6.73 | 65.5 | 9.81 | 6.75 |
| 12.40 | 64.2 | 9.82 | 6.60 | 64.4 | 9.82 | 6.62 | 64.5 | 9.82 | 6.63 | 64.7 | 9.82 | 6.65 | 64.8 | 9.82 | 6.66 | 65.0 | 9.82 | 6.68 | 65.1 | 9.82 | 6.69 | 65.2 | 9.82 | 6.71 | 65.4 | 9.82 | 6.72 | 65.5 | 9.82 | 6.74 |
| 12.50 | 64.2 | 9.83 | 6.60 | 64.4 | 9.83 | 6.61 | 64.5 | 9.83 | 6.62 | 64.7 | 9.83 | 6.64 | 64.8 | 9.83 | 6.65 | 65.0 | 9.83 | 6.67 | 65.1 | 9.83 | 6.68 | 65.3 | 9.83 | 6.70 | 65.4 | 9.83 | 6.71 | 65.6 | 9.83 | 6.73 |
| 12.60 | 64.3 | 9.84 | 6.59 | 64.4 | 9.84 | 6.60 | 64.6 | 9.84 | 6.62 | 64.7 | 9.84 | 6.63 | 64.9 | 9.84 | 6.65 | 65.0 | 9.84 | 6.66 | 65.1 | 9.84 | 6.68 | 65.3 | 9.84 | 6.69 | 65.4 | 9.84 | 6.70 | 65.6 | 9.84 | 6.72 |
| 12.70 | 64.3 | 9.85 | 6.58 | 64.4 | 9.85 | 6.59 | 64.6 | 9.85 | 6.61 | 64.7 | 9.85 | 6.62 | 64.9 | 9.85 | 6.64 | 65.0 | 9.85 | 6.65 | 65.2 | 9.85 | 6.67 | 65.3 | 9.85 | 6.68 | 65.5 | 9.85 | 6.70 | 65.6 | 9.85 | 6.71 |
| 12.80 | 64.3 | 9.86 | 6.57 | 64.5 | 9.86 | 6.58 | 64.6 | 9.86 | 6.60 | 64.8 | 9.86 | 6.61 | 64.9 | 9.86 | 6.63 | 65.1 | 9.86 | 6.64 | 65.2 | 9.86 | 6.66 | 65.3 | 9.86 | 6.67 | 65.5 | 9.86 | 6.69 | 65.6 | 9.86 | 6.70 |
| 12.90 | 64.3 | 9.87 | 6.56 | 64.5 | 9.87 | 6.57 | 64.6 | 9.87 | 6.59 | 64.8 | 9.87 | 6.60 | 64.9 | 9.87 | 6.62 | 65.1 | 9.87 | 6.63 | 65.2 | 9.87 | 6.65 | 65.4 | 9.87 | 6.66 | 65.5 | 9.87 | 6.68 | 65.7 | 9.87 | 6.69 |
| 13.00 | 64.4 | 9.89 | 6.55 | 64.5 | 9.89 | 6.57 | 64.7 | 9.89 | 6.58 | 64.8 | 9.89 | 6.60 | 65.0 | 9.89 | 6.61 | 65.1 | 9.89 | 6.62 | 65.2 | 9.89 | 6.64 | 65.4 | 9.89 | 6.65 | 65.5 | 9.89 | 6.67 | 65.7 | 9.89 | 6.68 |
| 13.10 | 64.4 | 9.90 | 6.54 | 64.5 | 9.90 | 6.56 | 64.7 | 9.90 | 6.57 | 64.8 | 9.90 | 6.59 | 65.0 | 9.90 | 6.60 | 65.1 | 9.90 | 6.62 | 65.3 | 9.90 | 6.63 | 65.4 | 9.90 | 6.65 | 65.6 | 9.90 | 6.66 | 65.7 | 9.90 | 6.68 |
| 13.20 | 64.4 | 9.91 | 6.53 | 64.6 | 9.91 | 6.55 | 64.7 | 9.91 | 6.56 | 64.9 | 9.91 | 6.58 | 65.0 | 9.91 | 6.59 | 65.1 | 9.91 | 6.61 | 65.3 | 9.91 | 6.62 | 65.4 | 9.91 | 6.64 | 65.6 | 9.91 | 6.65 | 65.7 | 9.91 | 6.67 |
| 13.30 | 64.4 | 9.92 | 6.52 | 64.6 | 9.92 | 6.54 | 64.7 | 9.92 | 6.55 | 64.9 | 9.92 | 6.57 | 65.0 | 9.92 | 6.58 | 65.2 | 9.92 | 6.60 | 65.3 | 9.92 | 6.61 | 65.5 | 9.92 | 6.63 | 65.6 | 9.92 | 6.64 | 65.8 | 9.92 | 6.66 |
| 13.40 | 64.5 | 9.93 | 6.51 | 64.6 | 9.93 | 6.53 | 64.8 | 9.93 | 6.54 | 64.9 | 9.93 | 6.56 | 65.1 | 9.93 | 6.57 | 65.2 | 9.93 | 6.59 | 65.3 | 9.93 | 6.60 | 65.5 | 9.93 | 6.62 | 65.6 | 9.93 | 6.63 | 65.8 | 9.93 | 6.65 |
| 13.50 | 64.5 | 9.94 | 6.51 | 64.6 | 9.94 | 6.52 | 64.8 | 9.94 | 6.54 | 64.9 | 9.94 | 6.55 | 65.1 | 9.94 | 6.57 | 65.2 | 9.94 | 6.58 | 65.4 | 9.94 | 6.60 | 65.5 | 9.94 | 6.61 | 65.7 | 9.94 | 6.62 | 65.8 | 9.94 | 6.64 |
| 13.60 | 64.5 | 9.95 | 6.50 | 64.7 | 9.95 | 6.51 | 64.8 | 9.95 | 6.53 | 65.0 | 9.95 | 6.54 | 65.1 | 9.95 | 6.56 | 65.2 | 9.95 | 6.57 | 65.4 | 9.95 | 6.59 | 65.5 | 9.95 | 6.60 | 65.7 | 9.95 | 6.62 | 65.8 | 9.95 | 6.63 |
| 13.70 | 64.5 | 9.97 | 6.49 | 64.7 | 9.97 | 6.50 | 64.8 | 9.97 | 6.52 | 65.0 | 9.97 | 6.53 | 65.1 | 9.97 | 6.55 | 65.3 | 9.97 | 6.56 | 65.4 | 9.97 | 6.58 | 65.6 | 9.97 | 6.59 | 65.7 | 9.97 | 6.61 | 65.9 | 9.97 | 6.62 |
| 13.80 | 64.6 | 9.98 | 6.48 | 64.7 | 9.98 | 6.49 | 64.9 | 9.98 | 6.51 | 65.0 | 9.98 | 6.52 | 65.1 | 9.98 | 6.54 | 65.3 | 9.98 | 6.55 | 65.4 | 9.98 | 6.57 | 65.6 | 9.98 | 6.58 | 65.7 | 9.98 | 6.60 | 65.9 | 9.98 | 6.61 |
| 13.90 | 64.6 | 9.99 | 6.47 | 64.7 | 9.99 | 6.48 | 64.9 | 9.99 | 6.50 | 65.0 | 9.99 | 6.51 | 65.2 | 9.99 | 6.53 | 65.3 | 9.99 | 6.54 | 65.5 | 9.99 | 6.56 | 65.6 | 9.99 | 6.57 | 65.8 | 9.99 | 6.59 | 65.9 | 9.99 | 6.60 |
| 14.00 | 64.6 | 10.00 | 6.46 | 64.8 | 10.00 | 6.48 | 64.9 | 10.00 | 6.49 | 65.1 | 10.00 | 6.51 | 65.2 | 10.00 | 6.52 | 65.4 | 10.00 | 6.54 | 65.5 | 10.00 | 6.55 | 65.7 | 10.00 | 6.57 | 65.8 | 10.00 | 6.58 | 66.0 | 10.00 | 6.60 |
| 14.10 | 64.6 | 10.01 | 6.45 | 64.8 | 10.01 | 6.47 | 64.9 | 10.01 | 6.48 | 65.1 | 10.01 | 6.50 | 65.2 | 10.01 | 6.51 | 65.4 | 10.01 | 6.53 | 65.5 | 10.01 | 6.54 | 65.7 | 10.01 | 6.56 | 65.8 | 10.01 | 6.57 | 66.0 | 10.01 | 6.59 |
| 14.20 | 64.6 | 10.02 | 6.44 | 64.8 | 10.02 | 6.46 | 64.9 | 10.02 | 6.47 | 65.1 | 10.02 | 6.49 | 65.3 | 10.02 | 6.50 | 65.4 | 10.02 | 6.52 | 65.6 | 10.02 | 6.53 | 65.7 | 10.02 | 6.55 | 65.9 | 10.02 | 6.56 | 66.0 | 10.02 | 6.58 |
| 14.30 | 64.7 | 10.04 | 6.43 | 64.8 | 10.04 | 6.45 | 65.0 | 10.04 | 6.46 | 65.1 | 10.04 | 6.48 | 65.3 | 10.04 | 6.49 | 65.4 | 10.04 | 6.51 | 65.6 | 10.04 | 6.52 | 65.7 | 10.04 | 6.54 | 65.9 | 10.04 | 6.55 | 66.0 | 10.04 | 6.57 |
| 14.40 | 64.7 | 10.05 | 6.42 | 64.8 | 10.05 | 6.44 | 65.0 | 10.05 | 6.45 | 65.2 | 10.05 | 6.47 | 65.3 | 10.05 | 6.48 | 65.5 | 10.05 | 6.50 | 65.6 | 10.05 | 6.51 | 65.8 | 10.05 | 6.53 | 65.9 | 10.05 | 6.54 | 66.1 | 10.05 | 6.56 |
| 14.50 | 64.7 | 10.06 | 6.41 | 64.9 | 10.06 | 6.43 | 65.0 | 10.06 | 6.44 | 65.2 | 10.06 | 6.46 | 65.3 | 10.06 | 6.47 | 65.5 | 10.06 | 6.49 | 65.6 | 10.06 | 6.50 | 65.8 | 10.06 | 6.52 | 65.9 | 10.06 | 6.53 | 66.1 | 10.06 | 6.55 |
| 14.60 | 64.7 | 10.07 | 6.40 | 64.9 | 10.07 | 6.42 | 65.0 | 10.07 | 6.43 | 65.2 | 10.07 | 6.45 | 65.4 | 10.07 | 6.46 | 65.5 | 10.07 | 6.48 | 65.7 | 10.07 | 6.50 | 65.8 | 10.07 | 6.51 | 66.0 | 10.07 | 6.53 | 66.1 | 10.07 | 6.54 |
| 14.70 | 64.8 | 10.08 | 6.40 | 64.9 | 10.08 | 6.41 | 65.1 | 10.08 | 6.43 | 65.2 | 10.08 | 6.44 | 65.4 | 10.08 | 6.46 | 65.5 | 10.08 | 6.47 | 65.7 | 10.08 | 6.49 | 65.8 | 10.08 | 6.50 | 66.0 | 10.08 | 6.52 | 66.1 | 10.08 | 6.53 |
| 14.80 | 64.8 | 10.09 | 6.39 | 64.9 | 10.09 | 6.40 | 65.1 | 10.09 | 6.42 | 65.3 | 10.09 | 6.43 | 65.4 | 10.09 | 6.45 | 65.6 | 10.09 | 6.46 | 65.7 | 10.09 | 6.48 | 65.9 | 10.09 | 6.49 | 66.0 | 10.09 | 6.51 | 66.2 | 10.09 | 6.52 |
| 14.90 | 64.8 | 10.11 | 6.38 | 65.0 | 10.11 | 6.39 | 65.1 | 10.11 | 6.41 | 65.3 | 10.11 | 6.42 | 65.4 | 10.11 | 6.44 | 65.6 | 10.11 | 6.45 | 65.7 | 10.11 | 6.47 | 65.9 | 10.11 | 6.48 | 66.0 | 10.11 | 6.50 | 66.2 | 10.11 | 6.51 |
| 15.00 | 64.8 | 10.12 | 6.37 | 65.0 | 10.12 | 6.38 | 65.2 | 10.12 | 6.40 | 65.3 | 10.12 | 6.41 | 65.5 | 10.12 | 6.43 | 65.6 | 10.12 | 6.44 | 65.8 | 10.12 | 6.46 | 65.9 | 10.12 | 6.47 | 66.1 | 10.12 | 6.49 | 66.2 | 10.12 | 6.50 |
| 15.10 | 64.9 | 10.13 | 6.36 | 65.0 | 10.13 | 6.37 | 65.2 | 10.13 | 6.39 | 65.3 | 10.13 | 6.40 | 65.5 | 10.13 | 6.42 | 65.6 | 10.13 | 6.43 | 65.8 | 10.13 | 6.45 | 65.9 | 10.13 | 6.46 | 66.1 | 10.13 | 6.48 | 66.2 | 10.13 | 6.49 |
| 15.20 | 64.9 | 10.14 | 6.35 | 65.0 | 10.14 | 6.36 | 65.2 | 10.14 | 6.38 | 65.4 | 10.14 | 6.39 | 65.5 | 10.14 | 6.41 | 65.7 | 10.14 | 6.42 | 65.8 | 10.14 | 6.44 | 66.0 | 10.14 | 6.45 | 66.1 | 10.14 | 6.47 | 66.3 | 10.14 | 6.49 |
| 15.30 | 64.9 | 10.15 | 6.34 | 65.1 | 10.15 | 6.35 | 65.2 | 10.15 | 6.37 | 65.4 | 10.15 | 6.38 | 65.5 | 10.15 | 6.40 | 65.7 | 10.15 | 6.41 | 65.8 | 10.15 | 6.43 | 66.0 | 10.15 | 6.45 | 66.1 | 10.15 | 6.46 | 66.3 | 10.15 | 6.48 |
| 15.40 | 64.9 | 10.17 | 6.33 | 65.1 | 10.17 | 6.34 | 65.3 | 10.17 | 6.36 | 65.4 | 10.17 | 6.38 | 65.6 | 10.17 | 6.39 | 65.7 | 10.17 | 6.41 | 65.9 | 10.17 | 6.42 | 66.0 | 10.17 | 6.44 | 66.2 | 10.17 | 6.45 | 66.3 | 10.17 | 6.47 |
| 15.50 | 65.0 | 10.18 | 6.32 | 65.1 | 10.18 | 6.34 | 65.3 | 10.18 | 6.35 | 65.4 | 10.18 | 6.37 | 65.6 | 10.18 | 6.38 | 65.7 | 10.18 | 6.40 | 65.9 | 10.18 | 6.41 | 66.0 | 10.18 | 6.43 | 66.2 | 10.18 | 6.44 | 66.3 | 10.18 | 6.46 |
| 15.60 | 65.0 | 10.19 | 6.31 | 65.2 | 10.19 | 6.33 | 65.3 | 10.19 | 6.34 | 65.5 | 10.19 | 6.36 | 65.6 | 10.19 | 6.37 | 65.8 | 10.19 | 6.39 | 65.9 | 10.19 | 6.40 | 66.1 | 10.19 | 6.42 | 66.2 | 10.19 | 6.43 | 66.4 | 10.19 | 6.45 |
| 15.70 | 65.0 | 10.20 | 6.30 | 65.2 | 10.20 | 6.32 | 65.3 | 10.20 | 6.33 | 65.5 | 10.20 | 6.35 | 65.6 | 10.20 | 6.36 | 65.8 | 10.20 | 6.38 | 65.9 | 10.20 | 6.39 | 66.1 | 10.20 | 6.41 | 66.2 | 10.20 | 6.42 | 66.4 | 10.20 | 6.44 |
| 15.80 | 65.0 | 10.21 | 6.29 | 65.2 | 10.21 | 6.31 | 65.4 | 10.21 | 6.32 | 65.5 | 10.21 | 6.34 | 65.7 | 10.21 | 6.35 | 65.8 | 10.21 | 6.37 | 66.0 | 10.21 | 6.38 | 66.1 | 10.21 | 6.40 | 66.3 | 10.21 | 6.41 | 66.4 | 10.21 | 6.43 |
| 15.90 | 65.1 | 10.23 | 6.28 | 65.2 | 10.23 | 6.30 | 65.4 | 10.23 | 6.31 | 65.5 | 10.23 | 6.33 | 65.7 | 10.23 | 6.34 | 65.8 | 10.23 | 6.36 | 66.0 | 10.23 | 6.37 | 66.1 | 10.23 | 6.39 | 66.3 | 10.23 | 6.40 | 66.5 | 10.23 | 6.42 |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 10.0; Water (ml) = (% Absorption x 10.0 / 100) + (10.0 - sample weight)

## 10-gram Mixograph: Absorption, Flour and Water Amount Table
## (15.0 - 15.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 15.00 | | | 15.10 | | | 15.20 | | | 15.30 | | | 15.40 | | | 15.50 | | | 15.60 | | | 15.70 | | | 15.80 | | | 15.90 | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml |
| 9.00 | 64.9 | 9.45 | 7.04 | 65.0 | 9.45 | 7.05 | 65.1 | 9.45 | 7.06 | 65.3 | 9.45 | 7.08 | 65.4 | 9.45 | 7.09 | 65.6 | 9.45 | 7.11 | 65.7 | 9.45 | 7.12 | 65.9 | 9.45 | 7.14 | 66.0 | 9.45 | 7.15 | 66.1 | 9.45 | 7.16 |
| 9.10 | 64.9 | 9.46 | 7.03 | 65.0 | 9.46 | 7.04 | 65.2 | 9.46 | 7.06 | 65.3 | 9.46 | 7.07 | 65.5 | 9.46 | 7.08 | 65.6 | 9.46 | 7.10 | 65.7 | 9.46 | 7.11 | 65.9 | 9.46 | 7.13 | 66.0 | 9.46 | 7.14 | 66.2 | 9.46 | 7.16 |
| 9.20 | 64.9 | 9.47 | 7.02 | 65.1 | 9.47 | 7.03 | 65.2 | 9.47 | 7.05 | 65.3 | 9.47 | 7.06 | 65.5 | 9.47 | 7.08 | 65.6 | 9.47 | 7.09 | 65.8 | 9.47 | 7.10 | 65.9 | 9.47 | 7.12 | 66.0 | 9.47 | 7.13 | 66.2 | 9.47 | 7.15 |
| 9.30 | 64.9 | 9.48 | 7.01 | 65.1 | 9.48 | 7.03 | 65.2 | 9.48 | 7.04 | 65.4 | 9.48 | 7.05 | 65.5 | 9.48 | 7.07 | 65.6 | 9.48 | 7.08 | 65.8 | 9.48 | 7.10 | 65.9 | 9.48 | 7.11 | 66.1 | 9.48 | 7.13 | 66.2 | 9.48 | 7.14 |
| 9.40 | 65.0 | 9.49 | 7.00 | 65.1 | 9.49 | 7.02 | 65.2 | 9.49 | 7.03 | 65.4 | 9.49 | 7.05 | 65.5 | 9.49 | 7.06 | 65.7 | 9.49 | 7.07 | 65.8 | 9.49 | 7.09 | 66.0 | 9.49 | 7.10 | 66.1 | 9.49 | 7.12 | 66.2 | 9.49 | 7.13 |
| 9.50 | 65.0 | 9.50 | 7.00 | 65.1 | 9.50 | 7.01 | 65.3 | 9.50 | 7.02 | 65.4 | 9.50 | 7.04 | 65.6 | 9.50 | 7.05 | 65.7 | 9.50 | 7.07 | 65.8 | 9.50 | 7.08 | 66.0 | 9.50 | 7.10 | 66.1 | 9.50 | 7.11 | 66.3 | 9.50 | 7.12 |
| 9.60 | 65.0 | 9.51 | 6.99 | 65.1 | 9.51 | 7.00 | 65.3 | 9.51 | 7.02 | 65.4 | 9.51 | 7.03 | 65.6 | 9.51 | 7.04 | 65.7 | 9.51 | 7.06 | 65.9 | 9.51 | 7.07 | 66.0 | 9.51 | 7.09 | 66.1 | 9.51 | 7.10 | 66.3 | 9.51 | 7.12 |
| 9.70 | 65.0 | 9.52 | 6.98 | 65.2 | 9.52 | 6.99 | 65.3 | 9.52 | 7.01 | 65.5 | 9.52 | 7.02 | 65.6 | 9.52 | 7.04 | 65.7 | 9.52 | 7.05 | 65.9 | 9.52 | 7.06 | 66.0 | 9.52 | 7.08 | 66.2 | 9.52 | 7.09 | 66.3 | 9.52 | 7.11 |
| 9.80 | 65.1 | 9.53 | 6.97 | 65.2 | 9.53 | 6.99 | 65.3 | 9.53 | 7.00 | 65.5 | 9.53 | 7.01 | 65.6 | 9.53 | 7.03 | 65.8 | 9.53 | 7.04 | 65.9 | 9.53 | 7.06 | 66.1 | 9.53 | 7.07 | 66.2 | 9.53 | 7.09 | 66.3 | 9.53 | 7.10 |
| 9.90 | 65.1 | 9.54 | 6.96 | 65.2 | 9.54 | 6.98 | 65.4 | 9.54 | 6.99 | 65.5 | 9.54 | 7.01 | 65.6 | 9.54 | 7.02 | 65.8 | 9.54 | 7.03 | 65.9 | 9.54 | 7.05 | 66.1 | 9.54 | 7.06 | 66.2 | 9.54 | 7.08 | 66.4 | 9.54 | 7.09 |
| 10.00 | 65.1 | 9.56 | 6.95 | 65.2 | 9.56 | 6.97 | 65.4 | 9.56 | 6.98 | 65.5 | 9.56 | 7.00 | 65.7 | 9.56 | 7.01 | 65.8 | 9.56 | 7.03 | 66.0 | 9.56 | 7.04 | 66.1 | 9.56 | 7.05 | 66.2 | 9.56 | 7.07 | 66.4 | 9.56 | 7.08 |
| 10.10 | 65.1 | 9.57 | 6.95 | 65.3 | 9.57 | 6.96 | 65.4 | 9.57 | 6.97 | 65.6 | 9.57 | 6.99 | 65.7 | 9.57 | 7.00 | 65.8 | 9.57 | 7.02 | 66.0 | 9.57 | 7.03 | 66.1 | 9.57 | 7.05 | 66.3 | 9.57 | 7.06 | 66.4 | 9.57 | 7.08 |
| 10.20 | 65.1 | 9.58 | 6.94 | 65.3 | 9.58 | 6.95 | 65.4 | 9.58 | 6.97 | 65.6 | 9.58 | 6.98 | 65.7 | 9.58 | 7.00 | 65.9 | 9.58 | 7.01 | 66.0 | 9.58 | 7.02 | 66.2 | 9.58 | 7.04 | 66.3 | 9.58 | 7.05 | 66.4 | 9.58 | 7.07 |
| 10.30 | 65.2 | 9.59 | 6.93 | 65.3 | 9.59 | 6.94 | 65.5 | 9.59 | 6.96 | 65.6 | 9.59 | 6.97 | 65.7 | 9.59 | 6.99 | 65.9 | 9.59 | 7.00 | 66.0 | 9.59 | 7.02 | 66.2 | 9.59 | 7.03 | 66.3 | 9.59 | 7.04 | 66.5 | 9.59 | 7.06 |
| 10.40 | 65.2 | 9.60 | 6.92 | 65.3 | 9.60 | 6.94 | 65.5 | 9.60 | 6.95 | 65.6 | 9.60 | 6.96 | 65.8 | 9.60 | 6.98 | 65.9 | 9.60 | 6.99 | 66.1 | 9.60 | 7.01 | 66.2 | 9.60 | 7.02 | 66.3 | 9.60 | 7.04 | 66.5 | 9.60 | 7.05 |
| 10.50 | 65.2 | 9.61 | 6.91 | 65.4 | 9.61 | 6.93 | 65.5 | 9.61 | 6.94 | 65.7 | 9.61 | 6.96 | 65.8 | 9.61 | 6.97 | 65.9 | 9.61 | 6.99 | 66.1 | 9.61 | 7.00 | 66.2 | 9.61 | 7.01 | 66.4 | 9.61 | 7.03 | 66.5 | 9.61 | 7.04 |
| 10.60 | 65.2 | 9.62 | 6.90 | 65.4 | 9.62 | 6.92 | 65.5 | 9.62 | 6.93 | 65.7 | 9.62 | 6.95 | 65.8 | 9.62 | 6.96 | 66.0 | 9.62 | 6.98 | 66.1 | 9.62 | 6.99 | 66.3 | 9.62 | 7.01 | 66.4 | 9.62 | 7.02 | 66.5 | 9.62 | 7.03 |
| 10.70 | 65.3 | 9.63 | 6.90 | 65.4 | 9.63 | 6.91 | 65.6 | 9.63 | 6.93 | 65.7 | 9.63 | 6.94 | 65.8 | 9.63 | 6.95 | 66.0 | 9.63 | 6.97 | 66.1 | 9.63 | 6.98 | 66.3 | 9.63 | 7.00 | 66.4 | 9.63 | 7.01 | 66.6 | 9.63 | 7.03 |
| 10.80 | 65.3 | 9.64 | 6.89 | 65.4 | 9.64 | 6.90 | 65.6 | 9.64 | 6.92 | 65.7 | 9.64 | 6.93 | 65.9 | 9.64 | 6.95 | 66.0 | 9.64 | 6.96 | 66.2 | 9.64 | 6.97 | 66.3 | 9.64 | 6.99 | 66.4 | 9.64 | 7.00 | 66.6 | 9.64 | 7.02 |
| 10.90 | 65.3 | 9.65 | 6.88 | 65.5 | 9.65 | 6.89 | 65.6 | 9.65 | 6.91 | 65.8 | 9.65 | 6.92 | 65.9 | 9.65 | 6.94 | 66.0 | 9.65 | 6.95 | 66.2 | 9.65 | 6.97 | 66.3 | 9.65 | 6.98 | 66.5 | 9.65 | 7.00 | 66.6 | 9.65 | 7.01 |
| 11.00 | 65.3 | 9.66 | 6.87 | 65.5 | 9.66 | 6.89 | 65.6 | 9.66 | 6.90 | 65.8 | 9.66 | 6.91 | 65.9 | 9.66 | 6.93 | 66.1 | 9.66 | 6.94 | 66.2 | 9.66 | 6.96 | 66.4 | 9.66 | 6.97 | 66.5 | 9.66 | 6.99 | 66.6 | 9.66 | 7.00 |
| 11.10 | 65.4 | 9.67 | 6.86 | 65.5 | 9.67 | 6.88 | 65.7 | 9.67 | 6.89 | 65.8 | 9.67 | 6.91 | 65.9 | 9.67 | 6.92 | 66.1 | 9.67 | 6.94 | 66.2 | 9.67 | 6.95 | 66.4 | 9.67 | 6.96 | 66.5 | 9.67 | 6.98 | 66.7 | 9.67 | 6.99 |
| 11.20 | 65.4 | 9.68 | 6.85 | 65.5 | 9.68 | 6.87 | 65.7 | 9.68 | 6.88 | 65.8 | 9.68 | 6.90 | 66.0 | 9.68 | 6.91 | 66.1 | 9.68 | 6.93 | 66.3 | 9.68 | 6.94 | 66.4 | 9.68 | 6.96 | 66.6 | 9.68 | 6.97 | 66.7 | 9.68 | 6.99 |
| 11.30 | 65.4 | 9.70 | 6.85 | 65.6 | 9.70 | 6.86 | 65.7 | 9.70 | 6.87 | 65.9 | 9.70 | 6.89 | 66.0 | 9.70 | 6.90 | 66.1 | 9.70 | 6.92 | 66.3 | 9.70 | 6.93 | 66.4 | 9.70 | 6.95 | 66.6 | 9.70 | 6.96 | 66.7 | 9.70 | 6.98 |
| 11.40 | 65.4 | 9.71 | 6.84 | 65.6 | 9.71 | 6.85 | 65.7 | 9.71 | 6.87 | 65.9 | 9.71 | 6.88 | 66.0 | 9.71 | 6.90 | 66.2 | 9.71 | 6.91 | 66.3 | 9.71 | 6.92 | 66.5 | 9.71 | 6.94 | 66.6 | 9.71 | 6.95 | 66.8 | 9.71 | 6.97 |
| 11.50 | 65.5 | 9.72 | 6.83 | 65.6 | 9.72 | 6.84 | 65.8 | 9.72 | 6.86 | 65.9 | 9.72 | 6.87 | 66.0 | 9.72 | 6.89 | 66.2 | 9.72 | 6.90 | 66.3 | 9.72 | 6.92 | 66.5 | 9.72 | 6.93 | 66.6 | 9.72 | 6.95 | 66.8 | 9.72 | 6.96 |
| 11.60 | 65.5 | 9.73 | 6.82 | 65.6 | 9.73 | 6.84 | 65.8 | 9.73 | 6.85 | 65.9 | 9.73 | 6.86 | 66.1 | 9.73 | 6.88 | 66.2 | 9.73 | 6.89 | 66.4 | 9.73 | 6.91 | 66.5 | 9.73 | 6.92 | 66.7 | 9.73 | 6.94 | 66.8 | 9.73 | 6.95 |
| 11.70 | 65.5 | 9.74 | 6.81 | 65.7 | 9.74 | 6.83 | 65.8 | 9.74 | 6.84 | 66.0 | 9.74 | 6.86 | 66.1 | 9.74 | 6.87 | 66.2 | 9.74 | 6.88 | 66.4 | 9.74 | 6.90 | 66.5 | 9.74 | 6.91 | 66.7 | 9.74 | 6.93 | 66.8 | 9.74 | 6.94 |
| 11.80 | 65.5 | 9.75 | 6.80 | 65.7 | 9.75 | 6.82 | 65.8 | 9.75 | 6.83 | 66.0 | 9.75 | 6.85 | 66.1 | 9.75 | 6.86 | 66.3 | 9.75 | 6.88 | 66.4 | 9.75 | 6.89 | 66.6 | 9.75 | 6.91 | 66.7 | 9.75 | 6.92 | 66.9 | 9.75 | 6.93 |
| 11.90 | 65.6 | 9.76 | 6.79 | 65.7 | 9.76 | 6.81 | 65.9 | 9.76 | 6.82 | 66.0 | 9.76 | 6.84 | 66.1 | 9.76 | 6.85 | 66.3 | 9.76 | 6.87 | 66.4 | 9.76 | 6.88 | 66.6 | 9.76 | 6.90 | 66.7 | 9.76 | 6.91 | 66.9 | 9.76 | 6.93 |
| 12.00 | 65.6 | 9.77 | 6.79 | 65.7 | 9.77 | 6.80 | 65.9 | 9.77 | 6.82 | 66.0 | 9.77 | 6.83 | 66.2 | 9.77 | 6.84 | 66.3 | 9.77 | 6.86 | 66.5 | 9.77 | 6.87 | 66.6 | 9.77 | 6.89 | 66.8 | 9.77 | 6.90 | 66.9 | 9.77 | 6.92 |
| 12.10 | 65.6 | 9.78 | 6.78 | 65.8 | 9.78 | 6.79 | 65.9 | 9.78 | 6.81 | 66.1 | 9.78 | 6.82 | 66.2 | 9.78 | 6.84 | 66.3 | 9.78 | 6.85 | 66.5 | 9.78 | 6.87 | 66.6 | 9.78 | 6.88 | 66.8 | 9.78 | 6.89 | 66.9 | 9.78 | 6.91 |
| 12.30 | 65.7 | 9.81 | 6.76 | 65.8 | 9.81 | 6.77 | 66.0 | 9.81 | 6.79 | 66.1 | 9.81 | 6.80 | 66.3 | 9.81 | 6.82 | 66.4 | 9.81 | 6.83 | 66.5 | 9.81 | 6.85 | 66.7 | 9.81 | 6.86 | 66.8 | 9.81 | 6.88 | 67.0 | 9.81 | 6.89 |
| 12.30 | 65.7 | 9.81 | 6.76 | 65.8 | 9.81 | 6.77 | 66.0 | 9.81 | 6.79 | 66.1 | 9.81 | 6.80 | 66.3 | 9.81 | 6.82 | 66.4 | 9.81 | 6.83 | 66.5 | 9.81 | 6.85 | 66.7 | 9.81 | 6.86 | 66.8 | 9.81 | 6.88 | 67.0 | 9.81 | 6.89 |
| 12.40 | 65.7 | 9.82 | 6.75 | 65.8 | 9.82 | 6.77 | 66.0 | 9.82 | 6.78 | 66.1 | 9.82 | 6.80 | 66.3 | 9.82 | 6.81 | 66.4 | 9.82 | 6.83 | 66.6 | 9.82 | 6.84 | 66.7 | 9.82 | 6.85 | 66.9 | 9.82 | 6.87 | 67.0 | 9.82 | 6.88 |
| 12.50 | 65.7 | 9.83 | 6.74 | 65.9 | 9.83 | 6.76 | 66.0 | 9.83 | 6.77 | 66.2 | 9.83 | 6.79 | 66.3 | 9.83 | 6.80 | 66.5 | 9.83 | 6.82 | 66.6 | 9.83 | 6.83 | 66.7 | 9.83 | 6.85 | 66.9 | 9.83 | 6.86 | 67.0 | 9.83 | 6.88 |
| 12.60 | 65.7 | 9.84 | 6.73 | 65.9 | 9.84 | 6.75 | 66.0 | 9.84 | 6.76 | 66.2 | 9.84 | 6.78 | 66.3 | 9.84 | 6.79 | 66.5 | 9.84 | 6.81 | 66.6 | 9.84 | 6.82 | 66.8 | 9.84 | 6.84 | 66.9 | 9.84 | 6.85 | 67.1 | 9.84 | 6.87 |
| 12.70 | 65.8 | 9.85 | 6.73 | 65.9 | 9.85 | 6.74 | 66.1 | 9.85 | 6.75 | 66.2 | 9.85 | 6.77 | 66.4 | 9.85 | 6.78 | 66.5 | 9.85 | 6.80 | 66.7 | 9.85 | 6.81 | 66.8 | 9.85 | 6.83 | 66.9 | 9.85 | 6.84 | 67.1 | 9.85 | 6.86 |
| 12.80 | 65.8 | 9.86 | 6.72 | 65.9 | 9.86 | 6.73 | 66.1 | 9.86 | 6.75 | 66.2 | 9.86 | 6.76 | 66.4 | 9.86 | 6.78 | 66.5 | 9.86 | 6.79 | 66.7 | 9.86 | 6.81 | 66.8 | 9.86 | 6.82 | 67.0 | 9.86 | 6.84 | 67.1 | 9.86 | 6.85 |
| 12.90 | 65.8 | 9.87 | 6.71 | 66.0 | 9.87 | 6.72 | 66.1 | 9.87 | 6.74 | 66.3 | 9.87 | 6.75 | 66.4 | 9.87 | 6.77 | 66.6 | 9.87 | 6.78 | 66.7 | 9.87 | 6.80 | 66.9 | 9.87 | 6.81 | 67.0 | 9.87 | 6.83 | 67.1 | 9.87 | 6.84 |
| 13.00 | 65.8 | 9.89 | 6.70 | 66.0 | 9.89 | 6.71 | 66.1 | 9.89 | 6.73 | 66.3 | 9.89 | 6.74 | 66.4 | 9.89 | 6.76 | 66.6 | 9.89 | 6.77 | 66.7 | 9.89 | 6.79 | 66.9 | 9.89 | 6.80 | 67.0 | 9.89 | 6.82 | 67.2 | 9.89 | 6.83 |
| 13.10 | 65.9 | 9.90 | 6.69 | 66.0 | 9.90 | 6.71 | 66.2 | 9.90 | 6.72 | 66.3 | 9.90 | 6.73 | 66.5 | 9.90 | 6.75 | 66.6 | 9.90 | 6.76 | 66.8 | 9.90 | 6.78 | 66.9 | 9.90 | 6.79 | 67.1 | 9.90 | 6.81 | 67.2 | 9.90 | 6.82 |
| 13.20 | 65.9 | 9.91 | 6.68 | 66.0 | 9.91 | 6.70 | 66.2 | 9.91 | 6.71 | 66.3 | 9.91 | 6.73 | 66.5 | 9.91 | 6.74 | 66.6 | 9.91 | 6.76 | 66.8 | 9.91 | 6.77 | 66.9 | 9.91 | 6.79 | 67.1 | 9.91 | 6.80 | 67.2 | 9.91 | 6.82 |
| 13.30 | 65.9 | 9.92 | 6.67 | 66.1 | 9.92 | 6.69 | 66.2 | 9.92 | 6.70 | 66.4 | 9.92 | 6.72 | 66.5 | 9.92 | 6.73 | 66.7 | 9.92 | 6.75 | 66.8 | 9.92 | 6.76 | 67.0 | 9.92 | 6.78 | 67.1 | 9.92 | 6.79 | 67.3 | 9.92 | 6.81 |
| 13.40 | 65.9 | 9.93 | 6.66 | 66.1 | 9.93 | 6.68 | 66.2 | 9.93 | 6.69 | 66.4 | 9.93 | 6.71 | 66.5 | 9.93 | 6.72 | 66.7 | 9.93 | 6.74 | 66.8 | 9.93 | 6.75 | 67.0 | 9.93 | 6.77 | 67.1 | 9.93 | 6.78 | 67.3 | 9.93 | 6.80 |
| 13.50 | 66.0 | 9.94 | 6.65 | 66.1 | 9.94 | 6.67 | 66.3 | 9.94 | 6.68 | 66.4 | 9.94 | 6.70 | 66.6 | 9.94 | 6.71 | 66.7 | 9.94 | 6.73 | 66.9 | 9.94 | 6.74 | 67.0 | 9.94 | 6.76 | 67.2 | 9.94 | 6.77 | 67.3 | 9.94 | 6.79 |
| 13.60 | 66.0 | 9.95 | 6.65 | 66.1 | 9.95 | 6.66 | 66.3 | 9.95 | 6.68 | 66.4 | 9.95 | 6.69 | 66.6 | 9.95 | 6.71 | 66.7 | 9.95 | 6.72 | 66.9 | 9.95 | 6.74 | 67.0 | 9.95 | 6.75 | 67.2 | 9.95 | 6.77 | 67.3 | 9.95 | 6.78 |
| 13.70 | 66.0 | 9.97 | 6.64 | 66.2 | 9.97 | 6.65 | 66.3 | 9.97 | 6.67 | 66.5 | 9.97 | 6.68 | 66.6 | 9.97 | 6.70 | 66.8 | 9.97 | 6.71 | 66.9 | 9.97 | 6.73 | 67.1 | 9.97 | 6.74 | 67.2 | 9.97 | 6.76 | 67.4 | 9.97 | 6.77 |
| 13.80 | 66.0 | 9.98 | 6.63 | 66.2 | 9.98 | 6.64 | 66.3 | 9.98 | 6.66 | 66.5 | 9.98 | 6.67 | 66.6 | 9.98 | 6.69 | 66.8 | 9.98 | 6.70 | 66.9 | 9.98 | 6.72 | 67.1 | 9.98 | 6.73 | 67.2 | 9.98 | 6.75 | 67.4 | 9.98 | 6.76 |
| 13.90 | 66.1 | 9.99 | 6.62 | 66.2 | 9.99 | 6.63 | 66.4 | 9.99 | 6.65 | 66.5 | 9.99 | 6.66 | 66.7 | 9.99 | 6.68 | 66.8 | 9.99 | 6.69 | 67.0 | 9.99 | 6.71 | 67.1 | 9.99 | 6.72 | 67.3 | 9.99 | 6.74 | 67.4 | 9.99 | 6.75 |
| 14.00 | 66.1 | 10.00 | 6.61 | 66.3 | 10.00 | 6.63 | 66.4 | 10.00 | 6.64 | 66.6 | 10.00 | 6.66 | 66.7 | 10.00 | 6.67 | 66.9 | 10.00 | 6.69 | 67.0 | 10.00 | 6.70 | 67.2 | 10.00 | 6.72 | 67.3 | 10.00 | 6.73 | 67.5 | 10.00 | 6.75 |
| 14.10 | 66.1 | 10.01 | 6.60 | 66.3 | 10.01 | 6.62 | 66.4 | 10.01 | 6.63 | 66.6 | 10.01 | 6.65 | 66.7 | 10.01 | 6.66 | 66.9 | 10.01 | 6.68 | 67.0 | 10.01 | 6.69 | 67.2 | 10.01 | 6.71 | 67.3 | 10.01 | 6.72 | 67.5 | 10.01 | 6.74 |
| 14.20 | 66.2 | 10.02 | 6.59 | 66.3 | 10.02 | 6.61 | 66.5 | 10.02 | 6.62 | 66.6 | 10.02 | 6.64 | 66.8 | 10.02 | 6.65 | 66.9 | 10.02 | 6.67 | 67.1 | 10.02 | 6.68 | 67.2 | 10.02 | 6.70 | 67.4 | 10.02 | 6.71 | 67.5 | 10.02 | 6.73 |
| 14.30 | 66.2 | 10.04 | 6.58 | 66.3 | 10.04 | 6.60 | 66.5 | 10.04 | 6.61 | 66.6 | 10.04 | 6.63 | 66.8 | 10.04 | 6.64 | 66.9 | 10.04 | 6.66 | 67.1 | 10.04 | 6.67 | 67.2 | 10.04 | 6.69 | 67.4 | 10.04 | 6.70 | 67.5 | 10.04 | 6.72 |
| 14.40 | 66.2 | 10.05 | 6.57 | 66.4 | 10.05 | 6.59 | 66.5 | 10.05 | 6.60 | 66.7 | 10.05 | 6.62 | 66.8 | 10.05 | 6.63 | 67.0 | 10.05 | 6.65 | 67.1 | 10.05 | 6.66 | 67.3 | 10.05 | 6.68 | 67.4 | 10.05 | 6.69 | 67.6 | 10.05 | 6.71 |
| 14.50 | 66.2 | 10.06 | 6.56 | 66.4 | 10.06 | 6.58 | 66.5 | 10.06 | 6.59 | 66.7 | 10.06 | 6.61 | 66.8 | 10.06 | 6.63 | 67.0 | 10.06 | 6.64 | 67.1 | 10.06 | 6.66 | 67.3 | 10.06 | 6.67 | 67.4 | 10.06 | 6.69 | 67.6 | 10.06 | 6.70 |
| 14.60 | 66.3 | 10.07 | 6.56 | 66.4 | 10.07 | 6.57 | 66.6 | 10.07 | 6.59 | 66.7 | 10.07 | 6.60 | 66.9 | 10.07 | 6.62 | 67.0 | 10.07 | 6.63 | 67.2 | 10.07 | 6.65 | 67.3 | 10.07 | 6.66 | 67.5 | 10.07 | 6.68 | 67.6 | 10.07 | 6.69 |
| 14.70 | 66.3 | 10.08 | 6.55 | 66.4 | 10.08 | 6.56 | 66.6 | 10.08 | 6.58 | 66.7 | 10.08 | 6.59 | 66.9 | 10.08 | 6.61 | 67.0 | 10.08 | 6.62 | 67.2 | 10.08 | 6.64 | 67.3 | 10.08 | 6.65 | 67.5 | 10.08 | 6.67 | 67.6 | 10.08 | 6.68 |
| 14.80 | 66.3 | 10.09 | 6.54 | 66.5 | 10.09 | 6.55 | 66.6 | 10.09 | 6.57 | 66.8 | 10.09 | 6.58 | 66.9 | 10.09 | 6.60 | 67.1 | 10.09 | 6.61 | 67.2 | 10.09 | 6.63 | 67.4 | 10.09 | 6.64 | 67.5 | 10.09 | 6.66 | 67.7 | 10.09 | 6.67 |
| 14.90 | 66.3 | 10.11 | 6.53 | 66.5 | 10.11 | 6.54 | 66.6 | 10.11 | 6.56 | 66.8 | 10.11 | 6.57 | 66.9 | 10.11 | 6.59 | 67.1 | 10.11 | 6.60 | 67.2 | 10.11 | 6.62 | 67.4 | 10.11 | 6.63 | 67.6 | 10.11 | 6.65 | 67.7 | 10.11 | 6.66 |
| 15.00 | 66.4 | 10.12 | 6.52 | 66.5 | 10.12 | 6.53 | 66.7 | 10.12 | 6.55 | 66.8 | 10.12 | 6.56 | 67.0 | 10.12 | 6.58 | 67.1 | 10.12 | 6.59 | 67.3 | 10.12 | 6.61 | 67.4 | 10.12 | 6.63 | 67.6 | 10.12 | 6.64 | 67.7 | 10.12 | 6.66 |
| 15.10 | 66.4 | 10.13 | 6.51 | 66.5 | 10.13 | 6.52 | 66.7 | 10.13 | 6.54 | 66.8 | 10.13 | 6.56 | 67.0 | 10.13 | 6.57 | 67.2 | 10.13 | 6.59 | 67.3 | 10.13 | 6.60 | 67.5 | 10.13 | 6.62 | 67.6 | 10.13 | 6.63 | 67.8 | 10.13 | 6.65 |
| 15.20 | 66.4 | 10.14 | 6.50 | 66.6 | 10.14 | 6.52 | 66.7 | 10.14 | 6.53 | 66.9 | 10.14 | 6.55 | 67.0 | 10.14 | 6.56 | 67.2 | 10.14 | 6.58 | 67.3 | 10.14 | 6.59 | 67.5 | 10.14 | 6.61 | 67.6 | 10.14 | 6.62 | 67.8 | 10.14 | 6.64 |
| 15.30 | 66.4 | 10.15 | 6.49 | 66.6 | 10.15 | 6.51 | 66.7 | 10.15 | 6.52 | 66.9 | 10.15 | 6.54 | 67.1 | 10.15 | 6.55 | 67.2 | 10.15 | 6.57 | 67.4 | 10.15 | 6.58 | 67.5 | 10.15 | 6.60 | 67.7 | 10.15 | 6.61 | 67.8 | 10.15 | 6.63 |
| 15.40 | 66.5 | 10.17 | 6.48 | 66.6 | 10.17 | 6.50 | 66.8 | 10.17 | 6.51 | 66.9 | 10.17 | 6.53 | 67.1 | 10.17 | 6.54 | 67.2 | 10.17 | 6.56 | 67.4 | 10.17 | 6.57 | 67.5 | 10.17 | 6.59 | 67.7 | 10.17 | 6.60 | 67.8 | 10.17 | 6.62 |
| 15.50 | 66.5 | 10.18 | 6.47 | 66.7 | 10.18 | 6.49 | 66.8 | 10.18 | 6.50 | 67.0 | 10.18 | 6.52 | 67.1 | 10.18 | 6.53 | 67.3 | 10.18 | 6.55 | 67.4 | 10.18 | 6.56 | 67.6 | 10.18 | 6.58 | 67.7 | 10.18 | 6.59 | 67.9 | 10.18 | 6.61 |
| 15.60 | 66.5 | 10.19 | 6.46 | 66.7 | 10.19 | 6.48 | 66.8 | 10.19 | 6.49 | 67.0 | 10.19 | 6.51 | 67.1 | 10.19 | 6.52 | 67.3 | 10.19 | 6.54 | 67.4 | 10.19 | 6.55 | 67.6 | 10.19 | 6.57 | 67.7 | 10.19 | 6.59 | 67.9 | 10.19 | 6.60 |
| 15.70 | 66.6 | 10.20 | 6.45 | 66.7 | 10.20 | 6.47 | 66.9 | 10.20 | 6.48 | 67.0 | 10.20 | 6.50 | 67.2 | 10.20 | 6.51 | 67.3 | 10.20 | 6.53 | 67.5 | 10.20 | 6.55 | 67.6 | 10.20 | 6.56 | 67.8 | 10.20 | 6.58 | 67.9 | 10.20 | 6.59 |
| 15.80 | 66.6 | 10.21 | 6.44 | 66.7 | 10.21 | 6.46 | 66.9 | 10.21 | 6.47 | 67.0 | 10.21 | 6.49 | 67.2 | 10.21 | 6.51 | 67.3 | 10.21 | 6.52 | 67.5 | 10.21 | 6.54 | 67.7 | 10.21 | 6.55 | 67.8 | 10.21 | 6.57 | 68.0 | 10.21 | 6.58 |
| 15.90 | 66.6 | 10.23 | 6.43 | 66.8 | 10.23 | 6.45 | 66.9 | 10.23 | 6.47 | 67.1 | 10.23 | 6.48 | 67.2 | 10.23 | 6.50 | 67.4 | 10.23 | 6.51 | 67.5 | 10.23 | 6.53 | 67.7 | 10.23 | 6.54 | 67.8 | 10.23 | 6.56 | 68.0 | 10.23 | 6.57 |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 10.0; Water (ml) = (% Absorption x 10.0 / 100) + (10.0 - sample weight)

# 35-gram Mixograph

Absorption, Flour and Water Amount Table

## 35-gram Mixograph: Absorption, Flour and Water Amount Table
## (8.0 - 8.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 8.00 | | | 8.10 | | | 8.20 | | | 8.30 | | | 8.40 | | | 8.50 | | | 8.60 | | | 8.70 | | | 8.80 | | | 8.90 | | | | | | | | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | | | | | | |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | | | | | | |
| 9.00 | 54.9 | 33.08 | 21.15 | 55.1 | 33.08 | 21.20 | 55.2 | 33.08 | 21.25 | 55.4 | 33.08 | 21.30 | 55.5 | 33.08 | 21.35 | 55.6 | 33.08 | 21.40 | 55.8 | 33.08 | 21.45 | 55.9 | 33.08 | 21.50 | 56.1 | 33.08 | 21.55 | 56.2 | 33.08 | 21.60 | | | | | | |
| 9.10 | 55.0 | 33.11 | 21.12 | 55.1 | 33.11 | 21.17 | 55.2 | 33.11 | 21.22 | 55.4 | 33.11 | 21.27 | 55.5 | 33.11 | 21.32 | 55.7 | 33.11 | 21.37 | 55.8 | 33.11 | 21.42 | 55.9 | 33.11 | 21.47 | 56.1 | 33.11 | 21.52 | 56.2 | 33.11 | 21.57 | | | | | | |
| 9.20 | 55.0 | 33.15 | 21.09 | 55.1 | 33.15 | 21.14 | 55.2 | 33.15 | 21.19 | 55.4 | 33.15 | 21.24 | 55.5 | 33.15 | 21.29 | 55.7 | 33.15 | 21.34 | 55.8 | 33.15 | 21.39 | 56.0 | 33.15 | 21.44 | 56.1 | 33.15 | 21.49 | 56.2 | 33.15 | 21.54 | | | | | | |
| 9.30 | 55.0 | 33.19 | 21.06 | 55.1 | 33.19 | 21.11 | 55.3 | 33.19 | 21.16 | 55.4 | 33.19 | 21.21 | 55.5 | 33.19 | 21.26 | 55.7 | 33.19 | 21.30 | 55.8 | 33.19 | 21.35 | 56.0 | 33.19 | 21.40 | 56.1 | 33.19 | 21.45 | 56.3 | 33.19 | 21.50 | | | | | | |
| 9.40 | 55.0 | 33.22 | 21.02 | 55.1 | 33.22 | 21.07 | 55.3 | 33.22 | 21.12 | 55.4 | 33.22 | 21.17 | 55.6 | 33.22 | 21.22 | 55.7 | 33.22 | 21.27 | 55.8 | 33.22 | 21.32 | 56.0 | 33.22 | 21.37 | 56.1 | 33.22 | 21.42 | 56.3 | 33.22 | 21.47 | | | | | | |
| 9.50 | 55.0 | 33.26 | 20.99 | 55.1 | 33.26 | 21.04 | 55.3 | 33.26 | 21.09 | 55.4 | 33.26 | 21.14 | 55.6 | 33.26 | 21.19 | 55.7 | 33.26 | 21.24 | 55.9 | 33.26 | 21.29 | 56.0 | 33.26 | 21.34 | 56.1 | 33.26 | 21.39 | 56.3 | 33.26 | 21.44 | | | | | | |
| 9.60 | 55.0 | 33.30 | 20.96 | 55.2 | 33.30 | 21.01 | 55.3 | 33.30 | 21.06 | 55.4 | 33.30 | 21.11 | 55.6 | 33.30 | 21.16 | 55.7 | 33.30 | 21.21 | 55.9 | 33.30 | 21.26 | 56.0 | 33.30 | 21.31 | 56.2 | 33.30 | 21.36 | 56.3 | 33.30 | 21.41 | | | | | | |
| 9.70 | 55.0 | 33.33 | 20.93 | 55.2 | 33.33 | 20.98 | 55.3 | 33.33 | 21.03 | 55.5 | 33.33 | 21.08 | 55.6 | 33.33 | 21.13 | 55.7 | 33.33 | 21.18 | 55.9 | 33.33 | 21.23 | 56.0 | 33.33 | 21.28 | 56.2 | 33.33 | 21.33 | 56.3 | 33.33 | 21.38 | | | | | | |
| 9.80 | 55.0 | 33.37 | 20.89 | 55.2 | 33.37 | 20.94 | 55.3 | 33.37 | 20.99 | 55.5 | 33.37 | 21.04 | 55.6 | 33.37 | 21.09 | 55.8 | 33.37 | 21.14 | 55.9 | 33.37 | 21.19 | 56.0 | 33.37 | 21.24 | 56.2 | 33.37 | 21.29 | 56.3 | 33.37 | 21.34 | | | | | | |
| 9.90 | 55.1 | 33.41 | 20.86 | 55.2 | 33.41 | 20.91 | 55.3 | 33.41 | 20.96 | 55.5 | 33.41 | 21.01 | 55.6 | 33.41 | 21.06 | 55.8 | 33.41 | 21.11 | 55.9 | 33.41 | 21.16 | 56.1 | 33.41 | 21.21 | 56.2 | 33.41 | 21.26 | 56.3 | 33.41 | 21.31 | | | | | | |
| 10.00 | 55.1 | 33.44 | 20.83 | 55.2 | 33.44 | 20.88 | 55.4 | 33.44 | 20.93 | 55.5 | 33.44 | 20.98 | 55.6 | 33.44 | 21.03 | 55.8 | 33.44 | 21.08 | 55.9 | 33.44 | 21.13 | 56.1 | 33.44 | 21.18 | 56.2 | 33.44 | 21.23 | 56.4 | 33.44 | 21.28 | | | | | | |
| 10.10 | 55.1 | 33.48 | 20.80 | 55.2 | 33.48 | 20.85 | 55.4 | 33.48 | 20.90 | 55.5 | 33.48 | 20.95 | 55.7 | 33.48 | 21.00 | 55.8 | 33.48 | 21.05 | 55.9 | 33.48 | 21.10 | 56.1 | 33.48 | 21.15 | 56.2 | 33.48 | 21.20 | 56.4 | 33.48 | 21.25 | | | | | | |
| 10.20 | 55.1 | 33.52 | 20.76 | 55.2 | 33.52 | 20.81 | 55.4 | 33.52 | 20.86 | 55.5 | 33.52 | 20.91 | 55.7 | 33.52 | 20.96 | 55.8 | 33.52 | 21.01 | 56.0 | 33.52 | 21.07 | 56.1 | 33.52 | 21.12 | 56.2 | 33.52 | 21.17 | 56.4 | 33.52 | 21.22 | | | | | | |
| 10.30 | 55.1 | 33.56 | 20.73 | 55.2 | 33.56 | 20.78 | 55.4 | 33.56 | 20.83 | 55.5 | 33.56 | 20.88 | 55.7 | 33.56 | 20.93 | 55.8 | 33.56 | 20.98 | 56.0 | 33.56 | 21.03 | 56.1 | 33.56 | 21.08 | 56.3 | 33.56 | 21.13 | 56.4 | 33.56 | 21.18 | | | | | | |
| 10.40 | 55.1 | 33.59 | 20.70 | 55.3 | 33.59 | 20.75 | 55.4 | 33.59 | 20.80 | 55.5 | 33.59 | 20.85 | 55.7 | 33.59 | 20.90 | 55.8 | 33.59 | 20.95 | 56.0 | 33.59 | 21.00 | 56.1 | 33.59 | 21.05 | 56.3 | 33.59 | 21.10 | 56.4 | 33.59 | 21.15 | | | | | | |
| 10.50 | 55.1 | 33.63 | 20.66 | 55.3 | 33.63 | 20.71 | 55.4 | 33.63 | 20.77 | 55.6 | 33.63 | 20.82 | 55.7 | 33.63 | 20.87 | 55.9 | 33.63 | 20.92 | 56.0 | 33.63 | 20.97 | 56.1 | 33.63 | 21.02 | 56.3 | 33.63 | 21.07 | 56.4 | 33.63 | 21.12 | | | | | | |
| 10.60 | 55.1 | 33.67 | 20.63 | 55.3 | 33.67 | 20.68 | 55.4 | 33.67 | 20.73 | 55.6 | 33.67 | 20.78 | 55.7 | 33.67 | 20.83 | 55.9 | 33.67 | 20.88 | 56.0 | 33.67 | 20.93 | 56.2 | 33.67 | 20.98 | 56.3 | 33.67 | 21.04 | 56.4 | 33.67 | 21.09 | | | | | | |
| 10.70 | 55.2 | 33.71 | 20.60 | 55.3 | 33.71 | 20.65 | 55.4 | 33.71 | 20.70 | 55.6 | 33.71 | 20.75 | 55.7 | 33.71 | 20.80 | 55.9 | 33.71 | 20.85 | 56.0 | 33.71 | 20.90 | 56.2 | 33.71 | 20.95 | 56.3 | 33.71 | 21.00 | 56.5 | 33.71 | 21.05 | | | | | | |
| 10.80 | 55.2 | 33.74 | 20.56 | 55.3 | 33.74 | 20.62 | 55.5 | 33.74 | 20.67 | 55.6 | 33.74 | 20.72 | 55.7 | 33.74 | 20.77 | 55.9 | 33.74 | 20.82 | 56.0 | 33.74 | 20.87 | 56.2 | 33.74 | 20.92 | 56.3 | 33.74 | 20.97 | 56.5 | 33.74 | 21.02 | | | | | | |
| 10.90 | 55.2 | 33.78 | 20.53 | 55.3 | 33.78 | 20.58 | 55.5 | 33.78 | 20.63 | 55.6 | 33.78 | 20.68 | 55.8 | 33.78 | 20.73 | 55.9 | 33.78 | 20.78 | 56.1 | 33.78 | 20.84 | 56.2 | 33.78 | 20.89 | 56.3 | 33.78 | 20.94 | 56.5 | 33.78 | 20.99 | | | | | | |
| 11.00 | 55.2 | 33.82 | 20.50 | 55.3 | 33.82 | 20.55 | 55.5 | 33.82 | 20.60 | 55.6 | 33.82 | 20.65 | 55.8 | 33.82 | 20.70 | 55.9 | 33.82 | 20.75 | 56.1 | 33.82 | 20.80 | 56.2 | 33.82 | 20.85 | 56.4 | 33.82 | 20.90 | 56.5 | 33.82 | 20.95 | | | | | | |
| 11.10 | 55.2 | 33.86 | 20.46 | 55.4 | 33.86 | 20.52 | 55.5 | 33.86 | 20.57 | 55.6 | 33.86 | 20.62 | 55.8 | 33.86 | 20.67 | 55.9 | 33.86 | 20.72 | 56.1 | 33.86 | 20.77 | 56.2 | 33.86 | 20.82 | 56.4 | 33.86 | 20.87 | 56.5 | 33.86 | 20.92 | | | | | | |
| 11.20 | 55.2 | 33.90 | 20.43 | 55.4 | 33.90 | 20.48 | 55.5 | 33.90 | 20.53 | 55.7 | 33.90 | 20.58 | 55.8 | 33.90 | 20.63 | 55.9 | 33.90 | 20.69 | 56.1 | 33.90 | 20.74 | 56.2 | 33.90 | 20.79 | 56.4 | 33.90 | 20.84 | 56.5 | 33.90 | 20.89 | | | | | | |
| 11.30 | 55.2 | 33.93 | 20.40 | 55.4 | 33.93 | 20.45 | 55.5 | 33.93 | 20.50 | 55.7 | 33.93 | 20.55 | 55.8 | 33.93 | 20.60 | 56.0 | 33.93 | 20.65 | 56.1 | 33.93 | 20.70 | 56.3 | 33.93 | 20.75 | 56.4 | 33.93 | 20.80 | 56.5 | 33.93 | 20.86 | | | | | | |
| 11.40 | 55.2 | 33.97 | 20.36 | 55.4 | 33.97 | 20.41 | 55.5 | 33.97 | 20.47 | 55.7 | 33.97 | 20.52 | 55.8 | 33.97 | 20.57 | 56.0 | 33.97 | 20.62 | 56.1 | 33.97 | 20.67 | 56.3 | 33.97 | 20.72 | 56.4 | 33.97 | 20.77 | 56.6 | 33.97 | 20.82 | | | | | | |
| 11.50 | 55.3 | 34.01 | 20.33 | 55.4 | 34.01 | 20.38 | 55.6 | 34.01 | 20.43 | 55.7 | 34.01 | 20.48 | 55.8 | 34.01 | 20.53 | 56.0 | 34.01 | 20.59 | 56.1 | 34.01 | 20.64 | 56.3 | 34.01 | 20.69 | 56.4 | 34.01 | 20.74 | 56.6 | 34.01 | 20.79 | | | | | | |
| 11.60 | 55.3 | 34.05 | 20.30 | 55.4 | 34.05 | 20.35 | 55.6 | 34.05 | 20.40 | 55.7 | 34.05 | 20.45 | 55.9 | 34.05 | 20.50 | 56.0 | 34.05 | 20.55 | 56.1 | 34.05 | 20.60 | 56.3 | 34.05 | 20.65 | 56.4 | 34.05 | 20.70 | 56.6 | 34.05 | 20.76 | | | | | | |
| 11.70 | 55.3 | 34.09 | 20.26 | 55.4 | 34.09 | 20.31 | 55.6 | 34.09 | 20.36 | 55.7 | 34.09 | 20.42 | 55.9 | 34.09 | 20.47 | 56.0 | 34.09 | 20.52 | 56.2 | 34.09 | 20.57 | 56.3 | 34.09 | 20.62 | 56.5 | 34.09 | 20.67 | 56.6 | 34.09 | 20.72 | | | | | | |
| 11.80 | 55.3 | 34.13 | 20.23 | 55.4 | 34.13 | 20.28 | 55.6 | 34.13 | 20.33 | 55.7 | 34.13 | 20.38 | 55.9 | 34.13 | 20.43 | 56.0 | 34.13 | 20.48 | 56.2 | 34.13 | 20.54 | 56.3 | 34.13 | 20.59 | 56.5 | 34.13 | 20.64 | 56.6 | 34.13 | 20.69 | | | | | | |
| 11.90 | 55.3 | 34.17 | 20.19 | 55.5 | 34.17 | 20.25 | 55.6 | 34.17 | 20.30 | 55.8 | 34.17 | 20.35 | 55.9 | 34.17 | 20.40 | 56.0 | 34.17 | 20.45 | 56.2 | 34.17 | 20.50 | 56.3 | 34.17 | 20.55 | 56.5 | 34.17 | 20.60 | 56.6 | 34.17 | 20.66 | | | | | | |
| 12.00 | 55.3 | 34.20 | 20.16 | 55.5 | 34.20 | 20.21 | 55.6 | 34.20 | 20.26 | 55.8 | 34.20 | 20.31 | 55.9 | 34.20 | 20.37 | 56.1 | 34.20 | 20.42 | 56.2 | 34.20 | 20.47 | 56.4 | 34.20 | 20.52 | 56.5 | 34.20 | 20.57 | 56.6 | 34.20 | 20.62 | | | | | | |
| 12.10 | 55.3 | 34.24 | 20.13 | 55.5 | 34.24 | 20.18 | 55.6 | 34.24 | 20.23 | 55.8 | 34.24 | 20.28 | 55.9 | 34.24 | 20.33 | 56.1 | 34.24 | 20.38 | 56.2 | 34.24 | 20.43 | 56.4 | 34.24 | 20.49 | 56.5 | 34.24 | 20.54 | 56.7 | 34.24 | 20.59 | | | | | | |
| 12.30 | 55.4 | 34.32 | 20.06 | 55.5 | 34.32 | 20.11 | 55.7 | 34.32 | 20.16 | 55.8 | 34.32 | 20.21 | 56.0 | 34.32 | 20.26 | 56.1 | 34.32 | 20.31 | 56.2 | 34.32 | 20.37 | 56.4 | 34.32 | 20.42 | 56.5 | 34.32 | 20.47 | 56.7 | 34.32 | 20.52 | | | | | | |
| 12.30 | 55.4 | 34.32 | 20.06 | 55.5 | 34.32 | 20.11 | 55.7 | 34.32 | 20.16 | 55.8 | 34.32 | 20.21 | 56.0 | 34.32 | 20.26 | 56.1 | 34.32 | 20.31 | 56.2 | 34.32 | 20.37 | 56.4 | 34.32 | 20.42 | 56.5 | 34.32 | 20.47 | 56.7 | 34.32 | 20.52 | | | | | | |
| 12.40 | 55.4 | 34.36 | 20.02 | 55.5 | 34.36 | 20.07 | 55.7 | 34.36 | 20.13 | 55.8 | 34.36 | 20.18 | 56.0 | 34.36 | 20.23 | 56.1 | 34.36 | 20.28 | 56.3 | 34.36 | 20.33 | 56.4 | 34.36 | 20.38 | 56.6 | 34.36 | 20.43 | 56.7 | 34.36 | 20.49 | | | | | | |
| 12.50 | 55.4 | 34.40 | 19.99 | 55.5 | 34.40 | 20.04 | 55.7 | 34.40 | 20.09 | 55.8 | 34.40 | 20.14 | 56.0 | 34.40 | 20.19 | 56.1 | 34.40 | 20.25 | 56.3 | 34.40 | 20.30 | 56.4 | 34.40 | 20.35 | 56.6 | 34.40 | 20.40 | 56.7 | 34.40 | 20.45 | | | | | | |
| 12.60 | 55.4 | 34.44 | 19.95 | 55.6 | 34.44 | 20.01 | 55.7 | 34.44 | 20.06 | 55.9 | 34.44 | 20.11 | 56.0 | 34.44 | 20.16 | 56.1 | 34.44 | 20.21 | 56.3 | 34.44 | 20.26 | 56.4 | 34.44 | 20.31 | 56.6 | 34.44 | 20.37 | 56.7 | 34.44 | 20.42 | | | | | | |
| 12.70 | 55.4 | 34.48 | 19.92 | 55.6 | 34.48 | 19.97 | 55.7 | 34.48 | 20.02 | 55.9 | 34.48 | 20.07 | 56.0 | 34.48 | 20.13 | 56.2 | 34.48 | 20.18 | 56.3 | 34.48 | 20.23 | 56.5 | 34.48 | 20.28 | 56.6 | 34.48 | 20.33 | 56.8 | 34.48 | 20.38 | | | | | | |
| 12.80 | 55.4 | 34.52 | 19.88 | 55.6 | 34.52 | 19.94 | 55.7 | 34.52 | 19.99 | 55.9 | 34.52 | 20.04 | 56.0 | 34.52 | 20.09 | 56.2 | 34.52 | 20.14 | 56.3 | 34.52 | 20.19 | 56.5 | 34.52 | 20.25 | 56.6 | 34.52 | 20.30 | 56.8 | 34.52 | 20.35 | | | | | | |
| 12.90 | 55.4 | 34.56 | 19.85 | 55.6 | 34.56 | 19.90 | 55.7 | 34.56 | 19.95 | 55.9 | 34.56 | 20.00 | 56.0 | 34.56 | 20.06 | 56.2 | 34.56 | 20.11 | 56.3 | 34.56 | 20.16 | 56.5 | 34.56 | 20.21 | 56.6 | 34.56 | 20.26 | 56.8 | 34.56 | 20.32 | | | | | | |
| 13.00 | 55.5 | 34.60 | 19.81 | 55.6 | 34.60 | 19.87 | 55.8 | 34.60 | 19.92 | 55.9 | 34.60 | 19.97 | 56.1 | 34.60 | 20.02 | 56.2 | 34.60 | 20.07 | 56.4 | 34.60 | 20.13 | 56.5 | 34.60 | 20.18 | 56.6 | 34.60 | 20.23 | 56.8 | 34.60 | 20.28 | | | | | | |
| 13.10 | 55.5 | 34.64 | 19.78 | 55.6 | 34.64 | 19.83 | 55.8 | 34.64 | 19.88 | 55.9 | 34.64 | 19.93 | 56.1 | 34.64 | 19.99 | 56.2 | 34.64 | 20.04 | 56.4 | 34.64 | 20.09 | 56.5 | 34.64 | 20.14 | 56.7 | 34.64 | 20.19 | 56.8 | 34.64 | 20.25 | | | | | | |
| 13.20 | 55.5 | 34.68 | 19.74 | 55.6 | 34.68 | 19.80 | 55.8 | 34.68 | 19.85 | 55.9 | 34.68 | 19.90 | 56.1 | 34.68 | 19.95 | 56.2 | 34.68 | 20.00 | 56.4 | 34.68 | 20.06 | 56.5 | 34.68 | 20.11 | 56.7 | 34.68 | 20.16 | 56.8 | 34.68 | 20.21 | | | | | | |
| 13.30 | 55.5 | 34.72 | 19.71 | 55.7 | 34.72 | 19.76 | 55.8 | 34.72 | 19.81 | 55.9 | 34.72 | 19.86 | 56.1 | 34.72 | 19.92 | 56.2 | 34.72 | 19.97 | 56.4 | 34.72 | 20.02 | 56.5 | 34.72 | 20.07 | 56.7 | 34.72 | 20.13 | 56.8 | 34.72 | 20.18 | | | | | | |
| 13.40 | 55.5 | 34.76 | 19.67 | 55.7 | 34.76 | 19.73 | 55.8 | 34.76 | 19.78 | 56.0 | 34.76 | 19.83 | 56.1 | 34.76 | 19.88 | 56.3 | 34.76 | 19.93 | 56.4 | 34.76 | 19.99 | 56.6 | 34.76 | 20.04 | 56.7 | 34.76 | 20.09 | 56.9 | 34.76 | 20.14 | | | | | | |
| 13.50 | 55.5 | 34.80 | 19.64 | 55.7 | 34.80 | 19.69 | 55.8 | 34.80 | 19.74 | 56.0 | 34.80 | 19.79 | 56.1 | 34.80 | 19.85 | 56.3 | 34.80 | 19.90 | 56.4 | 34.80 | 19.95 | 56.6 | 34.80 | 20.00 | 56.7 | 34.80 | 20.06 | 56.9 | 34.80 | 20.11 | | | | | | |
| 13.60 | 55.5 | 34.84 | 19.60 | 55.7 | 34.84 | 19.65 | 55.8 | 34.84 | 19.71 | 56.0 | 34.84 | 19.76 | 56.1 | 34.84 | 19.81 | 56.3 | 34.84 | 19.86 | 56.4 | 34.84 | 19.92 | 56.6 | 34.84 | 19.97 | 56.7 | 34.84 | 20.02 | 56.9 | 34.84 | 20.07 | | | | | | |
| 13.70 | 55.6 | 34.88 | 19.57 | 55.7 | 34.88 | 19.62 | 55.9 | 34.88 | 19.67 | 56.0 | 34.88 | 19.72 | 56.2 | 34.88 | 19.78 | 56.3 | 34.88 | 19.83 | 56.5 | 34.88 | 19.88 | 56.6 | 34.88 | 19.93 | 56.8 | 34.88 | 19.99 | 56.9 | 34.88 | 20.04 | | | | | | |
| 13.80 | 55.6 | 34.92 | 19.53 | 55.7 | 34.92 | 19.58 | 55.9 | 34.92 | 19.64 | 56.0 | 34.92 | 19.69 | 56.2 | 34.92 | 19.74 | 56.3 | 34.92 | 19.79 | 56.5 | 34.92 | 19.85 | 56.6 | 34.92 | 19.90 | 56.8 | 34.92 | 19.95 | 56.9 | 34.92 | 20.00 | | | | | | |
| 13.90 | 55.6 | 34.96 | 19.50 | 55.7 | 34.96 | 19.55 | 55.9 | 34.96 | 19.60 | 56.0 | 34.96 | 19.65 | 56.2 | 34.96 | 19.71 | 56.3 | 34.96 | 19.76 | 56.5 | 34.96 | 19.81 | 56.6 | 34.96 | 19.86 | 56.8 | 34.96 | 19.92 | 56.9 | 34.96 | 19.97 | | | | | | |
| 14.00 | 55.6 | 35.00 | 19.46 | 55.8 | 35.00 | 19.51 | 55.9 | 35.00 | 19.57 | 56.1 | 35.00 | 19.62 | 56.2 | 35.00 | 19.67 | 56.4 | 35.00 | 19.72 | 56.5 | 35.00 | 19.78 | 56.7 | 35.00 | 19.83 | 56.8 | 35.00 | 19.88 | 57.0 | 35.00 | 19.93 | | | | | | |
| 14.10 | 55.6 | 35.04 | 19.42 | 55.8 | 35.04 | 19.48 | 55.9 | 35.04 | 19.53 | 56.1 | 35.04 | 19.58 | 56.2 | 35.04 | 19.63 | 56.4 | 35.04 | 19.69 | 56.5 | 35.04 | 19.74 | 56.7 | 35.04 | 19.79 | 56.8 | 35.04 | 19.84 | 57.0 | 35.04 | 19.90 | | | | | | |
| 14.20 | 55.6 | 35.08 | 19.39 | 55.8 | 35.08 | 19.44 | 55.9 | 35.08 | 19.49 | 56.1 | 35.08 | 19.55 | 56.2 | 35.08 | 19.60 | 56.4 | 35.08 | 19.65 | 56.5 | 35.08 | 19.70 | 56.7 | 35.08 | 19.76 | 56.8 | 35.08 | 19.81 | 57.0 | 35.08 | 19.86 | | | | | | |
| 14.30 | 55.6 | 35.12 | 19.35 | 55.8 | 35.12 | 19.40 | 55.9 | 35.12 | 19.46 | 56.1 | 35.12 | 19.51 | 56.2 | 35.12 | 19.56 | 56.4 | 35.12 | 19.62 | 56.5 | 35.12 | 19.67 | 56.7 | 35.12 | 19.72 | 56.8 | 35.12 | 19.77 | 57.0 | 35.12 | 19.83 | | | | | | |
| 14.40 | 55.7 | 35.16 | 19.32 | 55.8 | 35.16 | 19.37 | 56.0 | 35.16 | 19.42 | 56.1 | 35.16 | 19.47 | 56.3 | 35.16 | 19.53 | 56.4 | 35.16 | 19.58 | 56.6 | 35.16 | 19.63 | 56.7 | 35.16 | 19.69 | 56.9 | 35.16 | 19.74 | 57.0 | 35.16 | 19.79 | | | | | | |
| 14.50 | 55.7 | 35.20 | 19.28 | 55.8 | 35.20 | 19.33 | 56.0 | 35.20 | 19.39 | 56.1 | 35.20 | 19.44 | 56.3 | 35.20 | 19.49 | 56.4 | 35.20 | 19.54 | 56.6 | 35.20 | 19.60 | 56.7 | 35.20 | 19.65 | 56.9 | 35.20 | 19.70 | 57.0 | 35.20 | 19.76 | | | | | | |
| 14.60 | 55.7 | 35.25 | 19.24 | 55.8 | 35.25 | 19.30 | 56.0 | 35.25 | 19.35 | 56.1 | 35.25 | 19.40 | 56.3 | 35.25 | 19.46 | 56.4 | 35.25 | 19.51 | 56.6 | 35.25 | 19.56 | 56.7 | 35.25 | 19.61 | 56.9 | 35.25 | 19.67 | 57.0 | 35.25 | 19.72 | | | | | | |
| 14.70 | 55.7 | 35.29 | 19.21 | 55.8 | 35.29 | 19.26 | 56.0 | 35.29 | 19.31 | 56.2 | 35.29 | 19.37 | 56.3 | 35.29 | 19.42 | 56.5 | 35.29 | 19.47 | 56.6 | 35.29 | 19.52 | 56.8 | 35.29 | 19.58 | 56.9 | 35.29 | 19.63 | 57.1 | 35.29 | 19.68 | | | | | | |
| 14.80 | 55.7 | 35.33 | 19.17 | 55.9 | 35.33 | 19.22 | 56.0 | 35.33 | 19.28 | 56.2 | 35.33 | 19.33 | 56.3 | 35.33 | 19.38 | 56.5 | 35.33 | 19.44 | 56.6 | 35.33 | 19.49 | 56.8 | 35.33 | 19.54 | 56.9 | 35.33 | 19.59 | 57.1 | 35.33 | 19.65 | | | | | | |
| 14.90 | 55.7 | 35.37 | 19.13 | 55.9 | 35.37 | 19.19 | 56.0 | 35.37 | 19.24 | 56.2 | 35.37 | 19.29 | 56.3 | 35.37 | 19.35 | 56.5 | 35.37 | 19.40 | 56.6 | 35.37 | 19.45 | 56.8 | 35.37 | 19.51 | 56.9 | 35.37 | 19.56 | 57.1 | 35.37 | 19.61 | | | | | | |
| 15.00 | 55.7 | 35.41 | 19.10 | 55.9 | 35.41 | 19.15 | 56.0 | 35.41 | 19.20 | 56.2 | 35.41 | 19.26 | 56.3 | 35.41 | 19.31 | 56.5 | 35.41 | 19.36 | 56.7 | 35.41 | 19.42 | 56.8 | 35.41 | 19.47 | 57.0 | 35.41 | 19.52 | 57.1 | 35.41 | 19.58 | | | | | | |
| 15.10 | 55.8 | 35.45 | 19.06 | 55.9 | 35.45 | 19.11 | 56.1 | 35.45 | 19.17 | 56.2 | 35.45 | 19.22 | 56.4 | 35.45 | 19.27 | 56.5 | 35.45 | 19.33 | 56.7 | 35.45 | 19.38 | 56.8 | 35.45 | 19.43 | 57.0 | 35.45 | 19.49 | 57.1 | 35.45 | 19.54 | | | | | | |
| 15.20 | 55.8 | 35.50 | 19.02 | 55.9 | 35.50 | 19.08 | 56.1 | 35.50 | 19.13 | 56.2 | 35.50 | 19.18 | 56.4 | 35.50 | 19.24 | 56.5 | 35.50 | 19.29 | 56.7 | 35.50 | 19.34 | 56.8 | 35.50 | 19.40 | 57.0 | 35.50 | 19.45 | 57.1 | 35.50 | 19.50 | | | | | | |
| 15.30 | 55.8 | 35.54 | 18.99 | 55.9 | 35.54 | 19.04 | 56.1 | 35.54 | 19.09 | 56.2 | 35.54 | 19.15 | 56.4 | 35.54 | 19.20 | 56.5 | 35.54 | 19.25 | 56.7 | 35.54 | 19.31 | 56.9 | 35.54 | 19.36 | 57.0 | 35.54 | 19.41 | 57.2 | 35.54 | 19.47 | | | | | | |
| 15.40 | 55.8 | 35.58 | 18.95 | 56.0 | 35.58 | 19.00 | 56.1 | 35.58 | 19.06 | 56.3 | 35.58 | 19.11 | 56.4 | 35.58 | 19.16 | 56.6 | 35.58 | 19.22 | 56.7 | 35.58 | 19.27 | 56.9 | 35.58 | 19.32 | 57.0 | 35.58 | 19.38 | 57.2 | 35.58 | 19.43 | | | | | | |
| 15.50 | 55.8 | 35.62 | 18.91 | 56.0 | 35.62 | 18.97 | 56.1 | 35.62 | 19.02 | 56.3 | 35.62 | 19.07 | 56.4 | 35.62 | 19.13 | 56.6 | 35.62 | 19.18 | 56.7 | 35.62 | 19.23 | 56.9 | 35.62 | 19.29 | 57.0 | 35.62 | 19.34 | 57.2 | 35.62 | 19.39 | | | | | | |
| 15.60 | 55.8 | 35.66 | 18.88 | 56.0 | 35.66 | 18.93 | 56.1 | 35.66 | 18.98 | 56.3 | 35.66 | 19.04 | 56.4 | 35.66 | 19.09 | 56.6 | 35.66 | 19.14 | 56.7 | 35.66 | 19.20 | 56.9 | 35.66 | 19.25 | 57.1 | 35.66 | 19.30 | 57.2 | 35.66 | 19.36 | | | | | | |
| 15.70 | 55.8 | 35.71 | 18.84 | 56.0 | 35.71 | 18.89 | 56.1 | 35.71 | 18.95 | 56.3 | 35.71 | 19.00 | 56.5 | 35.71 | 19.05 | 56.6 | 35.71 | 19.11 | 56.8 | 35.71 | 19.16 | 56.9 | 35.71 | 19.21 | 57.1 | 35.71 | 19.27 | 57.2 | 35.71 | 19.32 | | | | | | |
| 15.80 | 55.9 | 35.75 | 18.80 | 56.0 | 35.75 | 18.86 | 56.2 | 35.75 | 18.91 | 56.3 | 35.75 | 18.96 | 56.5 | 35.75 | 19.02 | 56.6 | 35.75 | 19.07 | 56.8 | 35.75 | 19.12 | 56.9 | 35.75 | 19.18 | 57.1 | 35.75 | 19.23 | 57.2 | 35.75 | 19.28 | | | | | | |
| 15.90 | 55.9 | 35.79 | 18.76 | 56.0 | 35.79 | 18.82 | 56.2 | 35.79 | 18.87 | 56.3 | 35.79 | 18.93 | 56.5 | 35.79 | 18.98 | 56.6 | 35.79 | 19.03 | 56.8 | 35.79 | 19.09 | 56.9 | 35.79 | 19.14 | 57.1 | 35.79 | 19.19 | 57.3 | 35.79 | 19.25 | | | | | | |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 35.0; Water (ml) = (% Absorption x 35.0 / 100) + (35.0 - sample weight)

## 35-gram Mixograph: Absorption, Flour and Water Amount Table
## (9.0 - 9.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 9.00 | | | 9.10 | | | 9.20 | | | 9.30 | | | 9.40 | | | 9.50 | | | 9.60 | | | 9.70 | | | 9.80 | | | 9.90 | | | | | | | | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | | | | | | |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | | | | | | |
| 9.00 | 56.4 | 33.08 | 21.65 | 56.5 | 33.08 | 21.70 | 56.6 | 33.08 | 21.75 | 56.8 | 33.08 | 21.80 | 56.9 | 33.08 | 21.85 | 57.1 | 33.08 | 21.90 | 57.2 | 33.08 | 21.95 | 57.4 | 33.08 | 22.00 | 57.5 | 33.08 | 22.05 | 57.6 | 33.08 | 22.10 | | | | | | |
| 9.10 | 56.4 | 33.11 | 21.62 | 56.5 | 33.11 | 21.67 | 56.7 | 33.11 | 21.72 | 56.8 | 33.11 | 21.77 | 56.9 | 33.11 | 21.82 | 57.1 | 33.11 | 21.87 | 57.2 | 33.11 | 21.92 | 57.4 | 33.11 | 21.96 | 57.5 | 33.11 | 22.01 | 57.6 | 33.11 | 22.06 | | | | | | |
| 9.20 | 56.4 | 33.15 | 21.59 | 56.5 | 33.15 | 21.64 | 56.7 | 33.15 | 21.68 | 56.8 | 33.15 | 21.73 | 57.0 | 33.15 | 21.78 | 57.1 | 33.15 | 21.83 | 57.2 | 33.15 | 21.88 | 57.4 | 33.15 | 21.93 | 57.5 | 33.15 | 21.98 | 57.7 | 33.15 | 22.03 | | | | | | |
| 9.30 | 56.4 | 33.19 | 21.55 | 56.5 | 33.19 | 21.60 | 56.7 | 33.19 | 21.65 | 56.8 | 33.19 | 21.70 | 57.0 | 33.19 | 21.75 | 57.1 | 33.19 | 21.80 | 57.3 | 33.19 | 21.85 | 57.4 | 33.19 | 21.90 | 57.5 | 33.19 | 21.95 | 57.7 | 33.19 | 22.00 | | | | | | |
| 9.40 | 56.4 | 33.22 | 21.52 | 56.6 | 33.22 | 21.57 | 56.7 | 33.22 | 21.62 | 56.8 | 33.22 | 21.67 | 57.0 | 33.22 | 21.72 | 57.1 | 33.22 | 21.77 | 57.3 | 33.22 | 21.82 | 57.4 | 33.22 | 21.87 | 57.6 | 33.22 | 21.92 | 57.7 | 33.22 | 21.97 | | | | | | |
| 9.50 | 56.4 | 33.26 | 21.49 | 56.6 | 33.26 | 21.54 | 56.7 | 33.26 | 21.59 | 56.9 | 33.26 | 21.64 | 57.0 | 33.26 | 21.69 | 57.1 | 33.26 | 21.74 | 57.3 | 33.26 | 21.79 | 57.4 | 33.26 | 21.84 | 57.6 | 33.26 | 21.89 | 57.7 | 33.26 | 21.94 | | | | | | |
| 9.60 | 56.4 | 33.30 | 21.46 | 56.6 | 33.30 | 21.51 | 56.7 | 33.30 | 21.56 | 56.9 | 33.30 | 21.61 | 57.0 | 33.30 | 21.66 | 57.2 | 33.30 | 21.71 | 57.3 | 33.30 | 21.76 | 57.4 | 33.30 | 21.81 | 57.6 | 33.30 | 21.86 | 57.7 | 33.30 | 21.91 | | | | | | |
| 9.70 | 56.5 | 33.33 | 21.43 | 56.6 | 33.33 | 21.48 | 56.7 | 33.33 | 21.53 | 56.9 | 33.33 | 21.58 | 57.0 | 33.33 | 21.63 | 57.2 | 33.33 | 21.68 | 57.3 | 33.33 | 21.73 | 57.5 | 33.33 | 21.78 | 57.6 | 33.33 | 21.83 | 57.7 | 33.33 | 21.88 | | | | | | |
| 9.80 | 56.5 | 33.37 | 21.39 | 56.6 | 33.37 | 21.44 | 56.8 | 33.37 | 21.49 | 56.9 | 33.37 | 21.54 | 57.0 | 33.37 | 21.59 | 57.2 | 33.37 | 21.64 | 57.3 | 33.37 | 21.70 | 57.5 | 33.37 | 21.75 | 57.6 | 33.37 | 21.80 | 57.8 | 33.37 | 21.85 | | | | | | |
| 9.90 | 56.5 | 33.41 | 21.36 | 56.6 | 33.41 | 21.41 | 56.8 | 33.41 | 21.46 | 56.9 | 33.41 | 21.51 | 57.1 | 33.41 | 21.56 | 57.2 | 33.41 | 21.61 | 57.3 | 33.41 | 21.66 | 57.5 | 33.41 | 21.71 | 57.6 | 33.41 | 21.76 | 57.8 | 33.41 | 21.81 | | | | | | |
| 10.00 | 56.5 | 33.44 | 21.33 | 56.6 | 33.44 | 21.38 | 56.8 | 33.44 | 21.43 | 56.9 | 33.44 | 21.48 | 57.1 | 33.44 | 21.53 | 57.2 | 33.44 | 21.58 | 57.4 | 33.44 | 21.63 | 57.5 | 33.44 | 21.68 | 57.6 | 33.44 | 21.73 | 57.8 | 33.44 | 21.78 | | | | | | |
| 10.10 | 56.5 | 33.48 | 21.30 | 56.7 | 33.48 | 21.35 | 56.8 | 33.48 | 21.40 | 56.9 | 33.48 | 21.45 | 57.1 | 33.48 | 21.50 | 57.2 | 33.48 | 21.55 | 57.4 | 33.48 | 21.60 | 57.5 | 33.48 | 21.65 | 57.7 | 33.48 | 21.70 | 57.8 | 33.48 | 21.75 | | | | | | |
| 10.20 | 56.5 | 33.52 | 21.27 | 56.7 | 33.52 | 21.32 | 56.8 | 33.52 | 21.37 | 57.0 | 33.52 | 21.42 | 57.1 | 33.52 | 21.47 | 57.2 | 33.52 | 21.52 | 57.4 | 33.52 | 21.57 | 57.5 | 33.52 | 21.62 | 57.7 | 33.52 | 21.67 | 57.8 | 33.52 | 21.72 | | | | | | |
| 10.30 | 56.5 | 33.56 | 21.23 | 56.7 | 33.56 | 21.28 | 56.8 | 33.56 | 21.33 | 57.0 | 33.56 | 21.38 | 57.1 | 33.56 | 21.44 | 57.3 | 33.56 | 21.49 | 57.4 | 33.56 | 21.54 | 57.5 | 33.56 | 21.59 | 57.7 | 33.56 | 21.64 | 57.8 | 33.56 | 21.69 | | | | | | |
| 10.40 | 56.6 | 33.59 | 21.20 | 56.7 | 33.59 | 21.25 | 56.8 | 33.59 | 21.30 | 57.0 | 33.59 | 21.35 | 57.1 | 33.59 | 21.40 | 57.3 | 33.59 | 21.45 | 57.4 | 33.59 | 21.50 | 57.6 | 33.59 | 21.55 | 57.7 | 33.59 | 21.60 | 57.9 | 33.59 | 21.65 | | | | | | |
| 10.50 | 56.6 | 33.63 | 21.17 | 56.7 | 33.63 | 21.22 | 56.9 | 33.63 | 21.27 | 57.0 | 33.63 | 21.32 | 57.1 | 33.63 | 21.37 | 57.3 | 33.63 | 21.42 | 57.4 | 33.63 | 21.47 | 57.6 | 33.63 | 21.52 | 57.7 | 33.63 | 21.57 | 57.9 | 33.63 | 21.62 | | | | | | |
| 10.60 | 56.6 | 33.67 | 21.14 | 56.7 | 33.67 | 21.19 | 56.9 | 33.67 | 21.24 | 57.0 | 33.67 | 21.29 | 57.2 | 33.67 | 21.34 | 57.3 | 33.67 | 21.39 | 57.5 | 33.67 | 21.44 | 57.6 | 33.67 | 21.49 | 57.7 | 33.67 | 21.54 | 57.9 | 33.67 | 21.59 | | | | | | |
| 10.70 | 56.6 | 33.71 | 21.10 | 56.7 | 33.71 | 21.15 | 56.9 | 33.71 | 21.20 | 57.0 | 33.71 | 21.26 | 57.2 | 33.71 | 21.31 | 57.3 | 33.71 | 21.36 | 57.5 | 33.71 | 21.41 | 57.6 | 33.71 | 21.46 | 57.8 | 33.71 | 21.51 | 57.9 | 33.71 | 21.56 | | | | | | |
| 10.80 | 56.6 | 33.74 | 21.07 | 56.8 | 33.74 | 21.12 | 56.9 | 33.74 | 21.17 | 57.0 | 33.74 | 21.22 | 57.2 | 33.74 | 21.27 | 57.3 | 33.74 | 21.32 | 57.5 | 33.74 | 21.37 | 57.6 | 33.74 | 21.43 | 57.8 | 33.74 | 21.48 | 57.9 | 33.74 | 21.53 | | | | | | |
| 10.90 | 56.6 | 33.78 | 21.04 | 56.8 | 33.78 | 21.09 | 56.9 | 33.78 | 21.14 | 57.1 | 33.78 | 21.19 | 57.2 | 33.78 | 21.24 | 57.4 | 33.78 | 21.29 | 57.5 | 33.78 | 21.34 | 57.6 | 33.78 | 21.39 | 57.8 | 33.78 | 21.44 | 57.9 | 33.78 | 21.49 | | | | | | |
| 11.00 | 56.6 | 33.82 | 21.01 | 56.8 | 33.82 | 21.06 | 56.9 | 33.82 | 21.11 | 57.1 | 33.82 | 21.16 | 57.2 | 33.82 | 21.21 | 57.4 | 33.82 | 21.26 | 57.5 | 33.82 | 21.31 | 57.7 | 33.82 | 21.36 | 57.8 | 33.82 | 21.41 | 57.9 | 33.82 | 21.46 | | | | | | |
| 11.10 | 56.7 | 33.86 | 20.97 | 56.8 | 33.86 | 21.02 | 56.9 | 33.86 | 21.07 | 57.1 | 33.86 | 21.12 | 57.2 | 33.86 | 21.18 | 57.4 | 33.86 | 21.23 | 57.5 | 33.86 | 21.28 | 57.7 | 33.86 | 21.33 | 57.8 | 33.86 | 21.38 | 58.0 | 33.86 | 21.43 | | | | | | |
| 11.20 | 56.7 | 33.90 | 20.94 | 56.8 | 33.90 | 20.99 | 57.0 | 33.90 | 21.04 | 57.1 | 33.90 | 21.09 | 57.3 | 33.90 | 21.14 | 57.4 | 33.90 | 21.19 | 57.5 | 33.90 | 21.24 | 57.7 | 33.90 | 21.30 | 57.8 | 33.90 | 21.35 | 58.0 | 33.90 | 21.40 | | | | | | |
| 11.30 | 56.7 | 33.93 | 20.91 | 56.8 | 33.93 | 20.96 | 57.0 | 33.93 | 21.01 | 57.1 | 33.93 | 21.06 | 57.3 | 33.93 | 21.11 | 57.4 | 33.93 | 21.16 | 57.6 | 33.93 | 21.21 | 57.7 | 33.93 | 21.26 | 57.9 | 33.93 | 21.31 | 58.0 | 33.93 | 21.36 | | | | | | |
| 11.40 | 56.7 | 33.97 | 20.87 | 56.8 | 33.97 | 20.92 | 57.0 | 33.97 | 20.98 | 57.1 | 33.97 | 21.03 | 57.3 | 33.97 | 21.08 | 57.4 | 33.97 | 21.13 | 57.6 | 33.97 | 21.18 | 57.7 | 33.97 | 21.23 | 57.9 | 33.97 | 21.28 | 58.0 | 33.97 | 21.33 | | | | | | |
| 11.50 | 56.7 | 34.01 | 20.84 | 56.9 | 34.01 | 20.89 | 57.0 | 34.01 | 20.94 | 57.2 | 34.01 | 20.99 | 57.3 | 34.01 | 21.04 | 57.4 | 34.01 | 21.10 | 57.6 | 34.01 | 21.15 | 57.7 | 34.01 | 21.20 | 57.9 | 34.01 | 21.25 | 58.0 | 34.01 | 21.30 | | | | | | |
| 11.60 | 56.7 | 34.05 | 20.81 | 56.9 | 34.05 | 20.86 | 57.0 | 34.05 | 20.91 | 57.2 | 34.05 | 20.96 | 57.3 | 34.05 | 21.01 | 57.5 | 34.05 | 21.06 | 57.6 | 34.05 | 21.11 | 57.8 | 34.05 | 21.16 | 57.9 | 34.05 | 21.22 | 58.0 | 34.05 | 21.27 | | | | | | |
| 11.70 | 56.7 | 34.09 | 20.77 | 56.9 | 34.09 | 20.82 | 57.0 | 34.09 | 20.88 | 57.2 | 34.09 | 20.93 | 57.3 | 34.09 | 20.98 | 57.5 | 34.09 | 21.03 | 57.6 | 34.09 | 21.08 | 57.8 | 34.09 | 21.13 | 57.9 | 34.09 | 21.18 | 58.1 | 34.09 | 21.23 | | | | | | |
| 11.80 | 56.8 | 34.13 | 20.74 | 56.9 | 34.13 | 20.79 | 57.1 | 34.13 | 20.84 | 57.2 | 34.13 | 20.89 | 57.3 | 34.13 | 20.94 | 57.5 | 34.13 | 21.00 | 57.6 | 34.13 | 21.05 | 57.8 | 34.13 | 21.10 | 57.9 | 34.13 | 21.15 | 58.1 | 34.13 | 21.20 | | | | | | |
| 11.90 | 56.8 | 34.17 | 20.71 | 56.9 | 34.17 | 20.76 | 57.1 | 34.17 | 20.81 | 57.2 | 34.17 | 20.86 | 57.4 | 34.17 | 20.91 | 57.5 | 34.17 | 20.96 | 57.7 | 34.17 | 21.01 | 57.8 | 34.17 | 21.07 | 57.9 | 34.17 | 21.12 | 58.1 | 34.17 | 21.17 | | | | | | |
| 12.00 | 56.8 | 34.20 | 20.67 | 56.9 | 34.20 | 20.72 | 57.1 | 34.20 | 20.78 | 57.2 | 34.20 | 20.83 | 57.4 | 34.20 | 20.88 | 57.5 | 34.20 | 20.93 | 57.7 | 34.20 | 20.98 | 57.8 | 34.20 | 21.03 | 58.0 | 34.20 | 21.08 | 58.1 | 34.20 | 21.13 | | | | | | |
| 12.10 | 56.8 | 34.24 | 20.64 | 57.0 | 34.24 | 20.69 | 57.1 | 34.24 | 20.74 | 57.2 | 34.24 | 20.79 | 57.4 | 34.24 | 20.84 | 57.5 | 34.24 | 20.90 | 57.7 | 34.24 | 20.95 | 57.8 | 34.24 | 21.00 | 58.0 | 34.24 | 21.05 | 58.1 | 34.24 | 21.10 | | | | | | |
| 12.30 | 56.8 | 34.32 | 20.57 | 57.0 | 34.32 | 20.62 | 57.1 | 34.32 | 20.67 | 57.3 | 34.32 | 20.73 | 57.4 | 34.32 | 20.78 | 57.6 | 34.32 | 20.83 | 57.7 | 34.32 | 20.88 | 57.9 | 34.32 | 20.93 | 58.0 | 34.32 | 20.98 | 58.2 | 34.32 | 21.04 | | | | | | |
| 12.30 | 56.8 | 34.32 | 20.57 | 57.0 | 34.32 | 20.62 | 57.1 | 34.32 | 20.67 | 57.3 | 34.32 | 20.73 | 57.4 | 34.32 | 20.78 | 57.6 | 34.32 | 20.83 | 57.7 | 34.32 | 20.88 | 57.9 | 34.32 | 20.93 | 58.0 | 34.32 | 20.98 | 58.2 | 34.32 | 21.04 | | | | | | |
| 12.40 | 56.9 | 34.36 | 20.54 | 57.0 | 34.36 | 20.59 | 57.1 | 34.36 | 20.64 | 57.3 | 34.36 | 20.69 | 57.4 | 34.36 | 20.74 | 57.6 | 34.36 | 20.80 | 57.7 | 34.36 | 20.85 | 57.9 | 34.36 | 20.90 | 58.0 | 34.36 | 20.95 | 58.2 | 34.36 | 21.00 | | | | | | |
| 12.50 | 56.9 | 34.40 | 20.50 | 57.0 | 34.40 | 20.56 | 57.2 | 34.40 | 20.61 | 57.3 | 34.40 | 20.66 | 57.5 | 34.40 | 20.71 | 57.6 | 34.40 | 20.76 | 57.8 | 34.40 | 20.81 | 57.9 | 34.40 | 20.87 | 58.0 | 34.40 | 20.92 | 58.2 | 34.40 | 20.97 | | | | | | |
| 12.60 | 56.9 | 34.44 | 20.47 | 57.0 | 34.44 | 20.52 | 57.2 | 34.44 | 20.57 | 57.3 | 34.44 | 20.62 | 57.5 | 34.44 | 20.68 | 57.6 | 34.44 | 20.73 | 57.8 | 34.44 | 20.78 | 57.9 | 34.44 | 20.83 | 58.1 | 34.44 | 20.88 | 58.2 | 34.44 | 20.93 | | | | | | |
| 12.70 | 56.9 | 34.48 | 20.44 | 57.0 | 34.48 | 20.49 | 57.2 | 34.48 | 20.54 | 57.3 | 34.48 | 20.59 | 57.5 | 34.48 | 20.64 | 57.6 | 34.48 | 20.69 | 57.8 | 34.48 | 20.75 | 57.9 | 34.48 | 20.80 | 58.1 | 34.48 | 20.85 | 58.2 | 34.48 | 20.90 | | | | | | |
| 12.80 | 56.9 | 34.52 | 20.40 | 57.1 | 34.52 | 20.45 | 57.2 | 34.52 | 20.51 | 57.4 | 34.52 | 20.56 | 57.5 | 34.52 | 20.61 | 57.7 | 34.52 | 20.66 | 57.8 | 34.52 | 20.71 | 57.9 | 34.52 | 20.76 | 58.1 | 34.52 | 20.82 | 58.2 | 34.52 | 20.87 | | | | | | |
| 12.90 | 56.9 | 34.56 | 20.37 | 57.1 | 34.56 | 20.42 | 57.2 | 34.56 | 20.47 | 57.4 | 34.56 | 20.52 | 57.5 | 34.56 | 20.57 | 57.7 | 34.56 | 20.63 | 57.8 | 34.56 | 20.68 | 58.0 | 34.56 | 20.73 | 58.1 | 34.56 | 20.78 | 58.3 | 34.56 | 20.83 | | | | | | |
| 13.00 | 56.9 | 34.60 | 20.33 | 57.1 | 34.60 | 20.38 | 57.2 | 34.60 | 20.44 | 57.4 | 34.60 | 20.49 | 57.5 | 34.60 | 20.54 | 57.7 | 34.60 | 20.59 | 57.8 | 34.60 | 20.64 | 58.0 | 34.60 | 20.70 | 58.1 | 34.60 | 20.75 | 58.3 | 34.60 | 20.80 | | | | | | |
| 13.10 | 57.0 | 34.64 | 20.30 | 57.1 | 34.64 | 20.35 | 57.3 | 34.64 | 20.40 | 57.4 | 34.64 | 20.45 | 57.6 | 34.64 | 20.51 | 57.7 | 34.64 | 20.56 | 57.9 | 34.64 | 20.61 | 58.0 | 34.64 | 20.66 | 58.1 | 34.64 | 20.71 | 58.3 | 34.64 | 20.77 | | | | | | |
| 13.20 | 57.0 | 34.68 | 20.26 | 57.1 | 34.68 | 20.32 | 57.3 | 34.68 | 20.37 | 57.4 | 34.68 | 20.42 | 57.6 | 34.68 | 20.47 | 57.7 | 34.68 | 20.52 | 57.9 | 34.68 | 20.58 | 58.0 | 34.68 | 20.63 | 58.2 | 34.68 | 20.68 | 58.3 | 34.68 | 20.73 | | | | | | |
| 13.30 | 57.0 | 34.72 | 20.23 | 57.1 | 34.72 | 20.28 | 57.3 | 34.72 | 20.33 | 57.4 | 34.72 | 20.39 | 57.6 | 34.72 | 20.44 | 57.7 | 34.72 | 20.49 | 57.9 | 34.72 | 20.54 | 58.0 | 34.72 | 20.59 | 58.2 | 34.72 | 20.65 | 58.3 | 34.72 | 20.70 | | | | | | |
| 13.40 | 57.0 | 34.76 | 20.19 | 57.2 | 34.76 | 20.25 | 57.3 | 34.76 | 20.30 | 57.5 | 34.76 | 20.35 | 57.6 | 34.76 | 20.40 | 57.8 | 34.76 | 20.46 | 57.9 | 34.76 | 20.51 | 58.0 | 34.76 | 20.56 | 58.2 | 34.76 | 20.61 | 58.3 | 34.76 | 20.66 | | | | | | |
| 13.50 | 57.0 | 34.80 | 20.16 | 57.2 | 34.80 | 20.21 | 57.3 | 34.80 | 20.26 | 57.5 | 34.80 | 20.32 | 57.6 | 34.80 | 20.37 | 57.8 | 34.80 | 20.42 | 57.9 | 34.80 | 20.47 | 58.1 | 34.80 | 20.53 | 58.2 | 34.80 | 20.58 | 58.4 | 34.80 | 20.63 | | | | | | |
| 13.60 | 57.0 | 34.84 | 20.13 | 57.2 | 34.84 | 20.18 | 57.3 | 34.84 | 20.23 | 57.5 | 34.84 | 20.28 | 57.6 | 34.84 | 20.33 | 57.8 | 34.84 | 20.39 | 57.9 | 34.84 | 20.44 | 58.1 | 34.84 | 20.49 | 58.2 | 34.84 | 20.54 | 58.4 | 34.84 | 20.60 | | | | | | |
| 13.70 | 57.1 | 34.88 | 20.09 | 57.2 | 34.88 | 20.14 | 57.4 | 34.88 | 20.19 | 57.5 | 34.88 | 20.25 | 57.7 | 34.88 | 20.30 | 57.8 | 34.88 | 20.35 | 57.9 | 34.88 | 20.40 | 58.1 | 34.88 | 20.46 | 58.2 | 34.88 | 20.51 | 58.4 | 34.88 | 20.56 | | | | | | |
| 13.80 | 57.1 | 34.92 | 20.06 | 57.2 | 34.92 | 20.11 | 57.4 | 34.92 | 20.16 | 57.5 | 34.92 | 20.21 | 57.7 | 34.92 | 20.26 | 57.8 | 34.92 | 20.32 | 58.0 | 34.92 | 20.37 | 58.1 | 34.92 | 20.42 | 58.3 | 34.92 | 20.47 | 58.4 | 34.92 | 20.53 | | | | | | |
| 13.90 | 57.1 | 34.96 | 20.02 | 57.2 | 34.96 | 20.07 | 57.4 | 34.96 | 20.13 | 57.5 | 34.96 | 20.18 | 57.7 | 34.96 | 20.23 | 57.8 | 34.96 | 20.28 | 58.0 | 34.96 | 20.33 | 58.1 | 34.96 | 20.39 | 58.3 | 34.96 | 20.44 | 58.4 | 34.96 | 20.49 | | | | | | |
| 14.00 | 57.1 | 35.00 | 19.99 | 57.3 | 35.00 | 20.04 | 57.4 | 35.00 | 20.09 | 57.6 | 35.00 | 20.14 | 57.7 | 35.00 | 20.20 | 57.9 | 35.00 | 20.25 | 58.0 | 35.00 | 20.30 | 58.2 | 35.00 | 20.35 | 58.3 | 35.00 | 20.41 | 58.5 | 35.00 | 20.46 | | | | | | |
| 14.10 | 57.1 | 35.04 | 19.95 | 57.3 | 35.04 | 20.00 | 57.4 | 35.04 | 20.05 | 57.6 | 35.04 | 20.11 | 57.7 | 35.04 | 20.16 | 57.9 | 35.04 | 20.21 | 58.0 | 35.04 | 20.27 | 58.2 | 35.04 | 20.32 | 58.3 | 35.04 | 20.37 | 58.5 | 35.04 | 20.42 | | | | | | |
| 14.20 | 57.1 | 35.08 | 19.91 | 57.3 | 35.08 | 19.97 | 57.4 | 35.08 | 20.02 | 57.6 | 35.08 | 20.07 | 57.7 | 35.08 | 20.12 | 57.9 | 35.08 | 20.18 | 58.0 | 35.08 | 20.23 | 58.2 | 35.08 | 20.28 | 58.3 | 35.08 | 20.34 | 58.5 | 35.08 | 20.39 | | | | | | |
| 14.30 | 57.1 | 35.12 | 19.88 | 57.3 | 35.12 | 19.93 | 57.4 | 35.12 | 19.98 | 57.6 | 35.12 | 20.04 | 57.7 | 35.12 | 20.09 | 57.9 | 35.12 | 20.14 | 58.1 | 35.12 | 20.20 | 58.2 | 35.12 | 20.25 | 58.4 | 35.12 | 20.30 | 58.5 | 35.12 | 20.35 | | | | | | |
| 14.40 | 57.2 | 35.16 | 19.84 | 57.3 | 35.16 | 19.90 | 57.5 | 35.16 | 19.95 | 57.6 | 35.16 | 20.00 | 57.8 | 35.16 | 20.05 | 57.9 | 35.16 | 20.11 | 58.1 | 35.16 | 20.16 | 58.2 | 35.16 | 20.21 | 58.4 | 35.16 | 20.27 | 58.5 | 35.16 | 20.32 | | | | | | |
| 14.50 | 57.2 | 35.20 | 19.81 | 57.3 | 35.20 | 19.86 | 57.5 | 35.20 | 19.91 | 57.6 | 35.20 | 19.97 | 57.8 | 35.20 | 20.02 | 57.9 | 35.20 | 20.07 | 58.1 | 35.20 | 20.12 | 58.2 | 35.20 | 20.18 | 58.4 | 35.20 | 20.23 | 58.5 | 35.20 | 20.28 | | | | | | |
| 14.60 | 57.2 | 35.25 | 19.77 | 57.3 | 35.25 | 19.83 | 57.5 | 35.25 | 19.88 | 57.6 | 35.25 | 19.93 | 57.8 | 35.25 | 19.98 | 58.0 | 35.25 | 20.04 | 58.1 | 35.25 | 20.09 | 58.3 | 35.25 | 20.14 | 58.4 | 35.25 | 20.20 | 58.6 | 35.25 | 20.25 | | | | | | |
| 14.70 | 57.2 | 35.29 | 19.74 | 57.4 | 35.29 | 19.79 | 57.5 | 35.29 | 19.84 | 57.7 | 35.29 | 19.90 | 57.8 | 35.29 | 19.95 | 58.0 | 35.29 | 20.00 | 58.1 | 35.29 | 20.05 | 58.3 | 35.29 | 20.11 | 58.4 | 35.29 | 20.16 | 58.6 | 35.29 | 20.21 | | | | | | |
| 14.80 | 57.2 | 35.33 | 19.70 | 57.4 | 35.33 | 19.75 | 57.5 | 35.33 | 19.81 | 57.7 | 35.33 | 19.86 | 57.8 | 35.33 | 19.91 | 58.0 | 35.33 | 19.97 | 58.1 | 35.33 | 20.02 | 58.3 | 35.33 | 20.07 | 58.4 | 35.33 | 20.12 | 58.6 | 35.33 | 20.18 | | | | | | |
| 14.90 | 57.2 | 35.37 | 19.66 | 57.4 | 35.37 | 19.72 | 57.5 | 35.37 | 19.77 | 57.7 | 35.37 | 19.82 | 57.8 | 35.37 | 19.88 | 58.0 | 35.37 | 19.93 | 58.2 | 35.37 | 19.98 | 58.3 | 35.37 | 20.04 | 58.5 | 35.37 | 20.09 | 58.6 | 35.37 | 20.14 | | | | | | |
| 15.00 | 57.3 | 35.41 | 19.63 | 57.4 | 35.41 | 19.68 | 57.6 | 35.41 | 19.74 | 57.7 | 35.41 | 19.79 | 57.9 | 35.41 | 19.84 | 58.0 | 35.41 | 19.89 | 58.2 | 35.41 | 19.95 | 58.3 | 35.41 | 20.00 | 58.5 | 35.41 | 20.05 | 58.6 | 35.41 | 20.11 | | | | | | |
| 15.10 | 57.3 | 35.45 | 19.59 | 57.4 | 35.45 | 19.65 | 57.6 | 35.45 | 19.70 | 57.7 | 35.45 | 19.75 | 57.9 | 35.45 | 19.81 | 58.0 | 35.45 | 19.86 | 58.2 | 35.45 | 19.91 | 58.3 | 35.45 | 19.97 | 58.5 | 35.45 | 20.02 | 58.6 | 35.45 | 20.07 | | | | | | |
| 15.20 | 57.3 | 35.50 | 19.56 | 57.4 | 35.50 | 19.61 | 57.6 | 35.50 | 19.66 | 57.7 | 35.50 | 19.72 | 57.9 | 35.50 | 19.77 | 58.1 | 35.50 | 19.82 | 58.2 | 35.50 | 19.88 | 58.4 | 35.50 | 19.93 | 58.5 | 35.50 | 19.98 | 58.7 | 35.50 | 20.04 | | | | | | |
| 15.30 | 57.3 | 35.54 | 19.52 | 57.5 | 35.54 | 19.57 | 57.6 | 35.54 | 19.63 | 57.8 | 35.54 | 19.68 | 57.9 | 35.54 | 19.73 | 58.1 | 35.54 | 19.79 | 58.2 | 35.54 | 19.84 | 58.4 | 35.54 | 19.89 | 58.5 | 35.54 | 19.95 | 58.7 | 35.54 | 20.00 | | | | | | |
| 15.40 | 57.3 | 35.58 | 19.48 | 57.5 | 35.58 | 19.54 | 57.6 | 35.58 | 19.59 | 57.8 | 35.58 | 19.64 | 57.9 | 35.58 | 19.70 | 58.1 | 35.58 | 19.75 | 58.2 | 35.58 | 19.80 | 58.4 | 35.58 | 19.86 | 58.5 | 35.58 | 19.91 | 58.7 | 35.58 | 19.96 | | | | | | |
| 15.50 | 57.3 | 35.62 | 19.45 | 57.5 | 35.62 | 19.50 | 57.6 | 35.62 | 19.55 | 57.8 | 35.62 | 19.61 | 58.0 | 35.62 | 19.66 | 58.1 | 35.62 | 19.71 | 58.3 | 35.62 | 19.77 | 58.4 | 35.62 | 19.82 | 58.6 | 35.62 | 19.88 | 58.7 | 35.62 | 19.93 | | | | | | |
| 15.60 | 57.4 | 35.66 | 19.41 | 57.5 | 35.66 | 19.46 | 57.7 | 35.66 | 19.52 | 57.8 | 35.66 | 19.57 | 58.0 | 35.66 | 19.63 | 58.1 | 35.66 | 19.68 | 58.3 | 35.66 | 19.73 | 58.4 | 35.66 | 19.79 | 58.6 | 35.66 | 19.84 | 58.7 | 35.66 | 19.89 | | | | | | |
| 15.70 | 57.4 | 35.71 | 19.37 | 57.5 | 35.71 | 19.43 | 57.7 | 35.71 | 19.48 | 57.8 | 35.71 | 19.54 | 58.0 | 35.71 | 19.59 | 58.1 | 35.71 | 19.64 | 58.3 | 35.71 | 19.70 | 58.4 | 35.71 | 19.75 | 58.6 | 35.71 | 19.80 | 58.7 | 35.71 | 19.86 | | | | | | |
| 15.80 | 57.4 | 35.75 | 19.34 | 57.5 | 35.75 | 19.39 | 57.7 | 35.75 | 19.45 | 57.8 | 35.75 | 19.50 | 58.0 | 35.75 | 19.55 | 58.2 | 35.75 | 19.61 | 58.3 | 35.75 | 19.66 | 58.5 | 35.75 | 19.71 | 58.6 | 35.75 | 19.77 | 58.8 | 35.75 | 19.82 | | | | | | |
| 15.90 | 57.4 | 35.79 | 19.30 | 57.6 | 35.79 | 19.35 | 57.7 | 35.79 | 19.41 | 57.9 | 35.79 | 19.46 | 58.0 | 35.79 | 19.52 | 58.2 | 35.79 | 19.57 | 58.3 | 35.79 | 19.62 | 58.5 | 35.79 | 19.68 | 58.6 | 35.79 | 19.73 | 58.8 | 35.79 | 19.78 | | | | | | |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 35.0; Water (ml) = (% Absorption x 35.0 / 100) + (35.0 - sample weight)

## 35-gram Mixograph: Absorption, Flour and Water Amount Table
## (10.0 - 10.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 10.00 | | | 10.10 | | | 10.20 | | | 10.30 | | | 10.40 | | | 10.50 | | | 10.60 | | | 10.70 | | | 10.80 | | | 10.90 | | | | | | | | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | | | | | | |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | | | | | | |
| 9.00 | 57.8 | 33.08 | 22.14 | 57.9 | 33.08 | 22.19 | 58.1 | 33.08 | 22.24 | 58.2 | 33.08 | 22.29 | 58.3 | 33.08 | 22.34 | 58.5 | 33.08 | 22.39 | 58.6 | 33.08 | 22.44 | 58.8 | 33.08 | 22.49 | 58.9 | 33.08 | 22.54 | 59.1 | 33.08 | 22.59 | | | | | | |
| 9.10 | 57.8 | 33.11 | 22.11 | 57.9 | 33.11 | 22.16 | 58.1 | 33.11 | 22.21 | 58.2 | 33.11 | 22.26 | 58.4 | 33.11 | 22.31 | 58.5 | 33.11 | 22.36 | 58.6 | 33.11 | 22.41 | 58.8 | 33.11 | 22.46 | 58.9 | 33.11 | 22.51 | 59.1 | 33.11 | 22.56 | | | | | | |
| 9.20 | 57.8 | 33.15 | 22.08 | 57.9 | 33.15 | 22.13 | 58.1 | 33.15 | 22.18 | 58.2 | 33.15 | 22.23 | 58.4 | 33.15 | 22.28 | 58.5 | 33.15 | 22.33 | 58.7 | 33.15 | 22.38 | 58.8 | 33.15 | 22.43 | 58.9 | 33.15 | 22.48 | 59.1 | 33.15 | 22.53 | | | | | | |
| 9.30 | 57.8 | 33.19 | 22.05 | 58.0 | 33.19 | 22.10 | 58.1 | 33.19 | 22.15 | 58.2 | 33.19 | 22.20 | 58.4 | 33.19 | 22.25 | 58.5 | 33.19 | 22.30 | 58.7 | 33.19 | 22.35 | 58.8 | 33.19 | 22.40 | 59.0 | 33.19 | 22.45 | 59.1 | 33.19 | 22.50 | | | | | | |
| 9.40 | 57.8 | 33.22 | 22.02 | 58.0 | 33.22 | 22.07 | 58.1 | 33.22 | 22.12 | 58.3 | 33.22 | 22.17 | 58.4 | 33.22 | 22.22 | 58.6 | 33.22 | 22.27 | 58.7 | 33.22 | 22.32 | 58.8 | 33.22 | 22.37 | 59.0 | 33.22 | 22.42 | 59.1 | 33.22 | 22.47 | | | | | | |
| 9.50 | 57.9 | 33.26 | 21.99 | 58.0 | 33.26 | 22.04 | 58.1 | 33.26 | 22.09 | 58.3 | 33.26 | 22.14 | 58.4 | 33.26 | 22.19 | 58.6 | 33.26 | 22.24 | 58.7 | 33.26 | 22.29 | 58.9 | 33.26 | 22.34 | 59.0 | 33.26 | 22.39 | 59.1 | 33.26 | 22.44 | | | | | | |
| 9.60 | 57.9 | 33.30 | 21.96 | 58.0 | 33.30 | 22.01 | 58.2 | 33.30 | 22.06 | 58.3 | 33.30 | 22.11 | 58.4 | 33.30 | 22.16 | 58.6 | 33.30 | 22.21 | 58.7 | 33.30 | 22.26 | 58.9 | 33.30 | 22.31 | 59.0 | 33.30 | 22.36 | 59.2 | 33.30 | 22.41 | | | | | | |
| 9.70 | 57.9 | 33.33 | 21.93 | 58.0 | 33.33 | 21.98 | 58.2 | 33.33 | 22.03 | 58.3 | 33.33 | 22.08 | 58.5 | 33.33 | 22.13 | 58.6 | 33.33 | 22.18 | 58.7 | 33.33 | 22.23 | 58.9 | 33.33 | 22.28 | 59.0 | 33.33 | 22.33 | 59.2 | 33.33 | 22.38 | | | | | | |
| 9.80 | 57.9 | 33.37 | 21.90 | 58.0 | 33.37 | 21.95 | 58.2 | 33.37 | 22.00 | 58.3 | 33.37 | 22.05 | 58.5 | 33.37 | 22.10 | 58.6 | 33.37 | 22.15 | 58.8 | 33.37 | 22.20 | 58.9 | 33.37 | 22.25 | 59.0 | 33.37 | 22.30 | 59.2 | 33.37 | 22.35 | | | | | | |
| 9.90 | 57.9 | 33.41 | 21.86 | 58.1 | 33.41 | 21.91 | 58.2 | 33.41 | 21.96 | 58.3 | 33.41 | 22.01 | 58.5 | 33.41 | 22.06 | 58.6 | 33.41 | 22.11 | 58.8 | 33.41 | 22.16 | 58.9 | 33.41 | 22.21 | 59.1 | 33.41 | 22.26 | 59.2 | 33.41 | 22.31 | | | | | | |
| 10.00 | 57.9 | 33.44 | 21.83 | 58.1 | 33.44 | 21.88 | 58.2 | 33.44 | 21.93 | 58.4 | 33.44 | 21.98 | 58.5 | 33.44 | 22.03 | 58.7 | 33.44 | 22.08 | 58.8 | 33.44 | 22.13 | 58.9 | 33.44 | 22.18 | 59.1 | 33.44 | 22.23 | 59.2 | 33.44 | 22.28 | | | | | | |
| 10.10 | 57.9 | 33.48 | 21.80 | 58.1 | 33.48 | 21.85 | 58.2 | 33.48 | 21.90 | 58.4 | 33.48 | 21.95 | 58.5 | 33.48 | 22.00 | 58.7 | 33.48 | 22.05 | 58.8 | 33.48 | 22.10 | 59.0 | 33.48 | 22.15 | 59.1 | 33.48 | 22.20 | 59.2 | 33.48 | 22.25 | | | | | | |
| 10.20 | 58.0 | 33.52 | 21.77 | 58.1 | 33.52 | 21.82 | 58.3 | 33.52 | 21.87 | 58.4 | 33.52 | 21.92 | 58.5 | 33.52 | 21.97 | 58.7 | 33.52 | 22.02 | 58.8 | 33.52 | 22.07 | 59.0 | 33.52 | 22.12 | 59.1 | 33.52 | 22.17 | 59.3 | 33.52 | 22.22 | | | | | | |
| 10.30 | 58.0 | 33.56 | 21.74 | 58.1 | 33.56 | 21.79 | 58.3 | 33.56 | 21.84 | 58.4 | 33.56 | 21.89 | 58.6 | 33.56 | 21.94 | 58.7 | 33.56 | 21.99 | 58.8 | 33.56 | 22.04 | 59.0 | 33.56 | 22.09 | 59.1 | 33.56 | 22.14 | 59.3 | 33.56 | 22.19 | | | | | | |
| 10.40 | 58.0 | 33.59 | 21.71 | 58.1 | 33.59 | 21.76 | 58.3 | 33.59 | 21.81 | 58.4 | 33.59 | 21.86 | 58.6 | 33.59 | 21.91 | 58.7 | 33.59 | 21.96 | 58.9 | 33.59 | 22.01 | 59.0 | 33.59 | 22.06 | 59.1 | 33.59 | 22.11 | 59.3 | 33.59 | 22.16 | | | | | | |
| 10.50 | 58.0 | 33.63 | 21.67 | 58.2 | 33.63 | 21.72 | 58.3 | 33.63 | 21.77 | 58.4 | 33.63 | 21.82 | 58.6 | 33.63 | 21.88 | 58.7 | 33.63 | 21.93 | 58.9 | 33.63 | 21.98 | 59.0 | 33.63 | 22.03 | 59.2 | 33.63 | 22.08 | 59.3 | 33.63 | 22.13 | | | | | | |
| 10.60 | 58.0 | 33.67 | 21.64 | 58.2 | 33.67 | 21.69 | 58.3 | 33.67 | 21.74 | 58.5 | 33.67 | 21.79 | 58.6 | 33.67 | 21.84 | 58.8 | 33.67 | 21.89 | 58.9 | 33.67 | 21.94 | 59.0 | 33.67 | 21.99 | 59.2 | 33.67 | 22.05 | 59.3 | 33.67 | 22.10 | | | | | | |
| 10.70 | 58.0 | 33.71 | 21.61 | 58.2 | 33.71 | 21.66 | 58.3 | 33.71 | 21.71 | 58.5 | 33.71 | 21.76 | 58.6 | 33.71 | 21.81 | 58.8 | 33.71 | 21.86 | 58.9 | 33.71 | 21.91 | 59.1 | 33.71 | 21.96 | 59.2 | 33.71 | 22.01 | 59.3 | 33.71 | 22.06 | | | | | | |
| 10.80 | 58.1 | 33.74 | 21.58 | 58.2 | 33.74 | 21.63 | 58.4 | 33.74 | 21.68 | 58.5 | 33.74 | 21.73 | 58.6 | 33.74 | 21.78 | 58.8 | 33.74 | 21.83 | 58.9 | 33.74 | 21.88 | 59.1 | 33.74 | 21.93 | 59.2 | 33.74 | 21.98 | 59.4 | 33.74 | 22.03 | | | | | | |
| 10.90 | 58.1 | 33.78 | 21.55 | 58.2 | 33.78 | 21.60 | 58.4 | 33.78 | 21.65 | 58.5 | 33.78 | 21.70 | 58.7 | 33.78 | 21.75 | 58.8 | 33.78 | 21.80 | 58.9 | 33.78 | 21.85 | 59.1 | 33.78 | 21.90 | 59.2 | 33.78 | 21.95 | 59.4 | 33.78 | 22.00 | | | | | | |
| 11.00 | 58.1 | 33.82 | 21.51 | 58.2 | 33.82 | 21.56 | 58.4 | 33.82 | 21.61 | 58.5 | 33.82 | 21.67 | 58.7 | 33.82 | 21.72 | 58.8 | 33.82 | 21.77 | 59.0 | 33.82 | 21.82 | 59.1 | 33.82 | 21.87 | 59.3 | 33.82 | 21.92 | 59.4 | 33.82 | 21.97 | | | | | | |
| 11.10 | 58.1 | 33.86 | 21.48 | 58.3 | 33.86 | 21.53 | 58.4 | 33.86 | 21.58 | 58.5 | 33.86 | 21.63 | 58.7 | 33.86 | 21.68 | 58.8 | 33.86 | 21.73 | 59.0 | 33.86 | 21.79 | 59.1 | 33.86 | 21.84 | 59.3 | 33.86 | 21.89 | 59.4 | 33.86 | 21.94 | | | | | | |
| 11.20 | 58.1 | 33.90 | 21.45 | 58.3 | 33.90 | 21.50 | 58.4 | 33.90 | 21.55 | 58.6 | 33.90 | 21.60 | 58.7 | 33.90 | 21.65 | 58.9 | 33.90 | 21.70 | 59.0 | 33.90 | 21.75 | 59.1 | 33.90 | 21.80 | 59.3 | 33.90 | 21.85 | 59.4 | 33.90 | 21.91 | | | | | | |
| 11.30 | 58.1 | 33.93 | 21.42 | 58.3 | 33.93 | 21.47 | 58.4 | 33.93 | 21.52 | 58.6 | 33.93 | 21.57 | 58.7 | 33.93 | 21.62 | 58.9 | 33.93 | 21.67 | 59.0 | 33.93 | 21.72 | 59.2 | 33.93 | 21.77 | 59.3 | 33.93 | 21.82 | 59.5 | 33.93 | 21.87 | | | | | | |
| 11.40 | 58.2 | 33.97 | 21.38 | 58.3 | 33.97 | 21.43 | 58.5 | 33.97 | 21.48 | 58.6 | 33.97 | 21.54 | 58.7 | 33.97 | 21.59 | 58.9 | 33.97 | 21.64 | 59.0 | 33.97 | 21.69 | 59.2 | 33.97 | 21.74 | 59.3 | 33.97 | 21.79 | 59.5 | 33.97 | 21.84 | | | | | | |
| 11.50 | 58.2 | 34.01 | 21.35 | 58.3 | 34.01 | 21.40 | 58.5 | 34.01 | 21.45 | 58.6 | 34.01 | 21.50 | 58.8 | 34.01 | 21.55 | 58.9 | 34.01 | 21.61 | 59.1 | 34.01 | 21.66 | 59.2 | 34.01 | 21.71 | 59.3 | 34.01 | 21.76 | 59.5 | 34.01 | 21.81 | | | | | | |
| 11.60 | 58.2 | 34.05 | 21.32 | 58.3 | 34.05 | 21.37 | 58.5 | 34.05 | 21.42 | 58.6 | 34.05 | 21.47 | 58.8 | 34.05 | 21.52 | 58.9 | 34.05 | 21.57 | 59.1 | 34.05 | 21.62 | 59.2 | 34.05 | 21.68 | 59.4 | 34.05 | 21.73 | 59.5 | 34.05 | 21.78 | | | | | | |
| 11.70 | 58.2 | 34.09 | 21.28 | 58.4 | 34.09 | 21.34 | 58.5 | 34.09 | 21.39 | 58.6 | 34.09 | 21.44 | 58.8 | 34.09 | 21.49 | 58.9 | 34.09 | 21.54 | 59.1 | 34.09 | 21.59 | 59.2 | 34.09 | 21.64 | 59.4 | 34.09 | 21.69 | 59.5 | 34.09 | 21.75 | | | | | | |
| 11.80 | 58.2 | 34.13 | 21.25 | 58.4 | 34.13 | 21.30 | 58.5 | 34.13 | 21.35 | 58.7 | 34.13 | 21.41 | 58.8 | 34.13 | 21.46 | 59.0 | 34.13 | 21.51 | 59.1 | 34.13 | 21.56 | 59.2 | 34.13 | 21.61 | 59.4 | 34.13 | 21.66 | 59.5 | 34.13 | 21.71 | | | | | | |
| 11.90 | 58.2 | 34.17 | 21.22 | 58.4 | 34.17 | 21.27 | 58.5 | 34.17 | 21.32 | 58.7 | 34.17 | 21.37 | 58.8 | 34.17 | 21.42 | 59.0 | 34.17 | 21.48 | 59.1 | 34.17 | 21.53 | 59.3 | 34.17 | 21.58 | 59.4 | 34.17 | 21.63 | 59.6 | 34.17 | 21.68 | | | | | | |
| 12.00 | 58.3 | 34.20 | 21.19 | 58.4 | 34.20 | 21.24 | 58.6 | 34.20 | 21.29 | 58.7 | 34.20 | 21.34 | 58.8 | 34.20 | 21.39 | 59.0 | 34.20 | 21.44 | 59.1 | 34.20 | 21.49 | 59.3 | 34.20 | 21.55 | 59.4 | 34.20 | 21.60 | 59.6 | 34.20 | 21.65 | | | | | | |
| 12.10 | 58.3 | 34.24 | 21.15 | 58.4 | 34.24 | 21.20 | 58.6 | 34.24 | 21.26 | 58.7 | 34.24 | 21.31 | 58.9 | 34.24 | 21.36 | 59.0 | 34.24 | 21.41 | 59.2 | 34.24 | 21.46 | 59.3 | 34.24 | 21.51 | 59.4 | 34.24 | 21.56 | 59.6 | 34.24 | 21.62 | | | | | | |
| 12.30 | 58.3 | 34.32 | 21.09 | 58.5 | 34.32 | 21.14 | 58.6 | 34.32 | 21.19 | 58.8 | 34.32 | 21.24 | 58.9 | 34.32 | 21.29 | 59.0 | 34.32 | 21.34 | 59.2 | 34.32 | 21.40 | 59.3 | 34.32 | 21.45 | 59.5 | 34.32 | 21.50 | 59.6 | 34.32 | 21.55 | | | | | | |
| 12.30 | 58.3 | 34.32 | 21.09 | 58.5 | 34.32 | 21.14 | 58.6 | 34.32 | 21.19 | 58.8 | 34.32 | 21.24 | 58.9 | 34.32 | 21.29 | 59.0 | 34.32 | 21.34 | 59.2 | 34.32 | 21.40 | 59.3 | 34.32 | 21.45 | 59.5 | 34.32 | 21.50 | 59.6 | 34.32 | 21.55 | | | | | | |
| 12.40 | 58.3 | 34.36 | 21.05 | 58.5 | 34.36 | 21.10 | 58.6 | 34.36 | 21.16 | 58.8 | 34.36 | 21.21 | 58.9 | 34.36 | 21.26 | 59.1 | 34.36 | 21.31 | 59.2 | 34.36 | 21.36 | 59.4 | 34.36 | 21.41 | 59.5 | 34.36 | 21.47 | 59.7 | 34.36 | 21.52 | | | | | | |
| 12.50 | 58.3 | 34.40 | 21.02 | 58.5 | 34.40 | 21.07 | 58.6 | 34.40 | 21.12 | 58.8 | 34.40 | 21.17 | 58.9 | 34.40 | 21.23 | 59.1 | 34.40 | 21.28 | 59.2 | 34.40 | 21.33 | 59.4 | 34.40 | 21.38 | 59.5 | 34.40 | 21.43 | 59.7 | 34.40 | 21.48 | | | | | | |
| 12.60 | 58.4 | 34.44 | 20.99 | 58.5 | 34.44 | 21.04 | 58.7 | 34.44 | 21.09 | 58.8 | 34.44 | 21.14 | 59.0 | 34.44 | 21.19 | 59.1 | 34.44 | 21.24 | 59.2 | 34.44 | 21.30 | 59.4 | 34.44 | 21.35 | 59.5 | 34.44 | 21.40 | 59.7 | 34.44 | 21.45 | | | | | | |
| 12.70 | 58.4 | 34.48 | 20.95 | 58.5 | 34.48 | 21.00 | 58.7 | 34.48 | 21.06 | 58.8 | 34.48 | 21.11 | 59.0 | 34.48 | 21.16 | 59.1 | 34.48 | 21.21 | 59.3 | 34.48 | 21.26 | 59.4 | 34.48 | 21.32 | 59.6 | 34.48 | 21.37 | 59.7 | 34.48 | 21.42 | | | | | | |
| 12.80 | 58.4 | 34.52 | 20.92 | 58.5 | 34.52 | 20.97 | 58.7 | 34.52 | 21.02 | 58.8 | 34.52 | 21.07 | 59.0 | 34.52 | 21.13 | 59.1 | 34.52 | 21.18 | 59.3 | 34.52 | 21.23 | 59.4 | 34.52 | 21.28 | 59.6 | 34.52 | 21.33 | 59.7 | 34.52 | 21.39 | | | | | | |
| 12.90 | 58.4 | 34.56 | 20.89 | 58.6 | 34.56 | 20.94 | 58.7 | 34.56 | 20.99 | 58.9 | 34.56 | 21.04 | 59.0 | 34.56 | 21.09 | 59.2 | 34.56 | 21.14 | 59.3 | 34.56 | 21.20 | 59.4 | 34.56 | 21.25 | 59.6 | 34.56 | 21.30 | 59.7 | 34.56 | 21.35 | | | | | | |
| 13.00 | 58.4 | 34.60 | 20.85 | 58.6 | 34.60 | 20.90 | 58.7 | 34.60 | 20.96 | 58.9 | 34.60 | 21.01 | 59.0 | 34.60 | 21.06 | 59.2 | 34.60 | 21.11 | 59.3 | 34.60 | 21.16 | 59.5 | 34.60 | 21.22 | 59.6 | 34.60 | 21.27 | 59.8 | 34.60 | 21.32 | | | | | | |
| 13.10 | 58.4 | 34.64 | 20.82 | 58.6 | 34.64 | 20.87 | 58.7 | 34.64 | 20.92 | 58.9 | 34.64 | 20.97 | 59.0 | 34.64 | 21.03 | 59.2 | 34.64 | 21.08 | 59.3 | 34.64 | 21.13 | 59.5 | 34.64 | 21.18 | 59.6 | 34.64 | 21.23 | 59.8 | 34.64 | 21.29 | | | | | | |
| 13.20 | 58.5 | 34.68 | 20.78 | 58.6 | 34.68 | 20.84 | 58.8 | 34.68 | 20.89 | 58.9 | 34.68 | 20.94 | 59.1 | 34.68 | 20.99 | 59.2 | 34.68 | 21.04 | 59.4 | 34.68 | 21.10 | 59.5 | 34.68 | 21.15 | 59.7 | 34.68 | 21.20 | 59.8 | 34.68 | 21.25 | | | | | | |
| 13.30 | 58.5 | 34.72 | 20.75 | 58.6 | 34.72 | 20.80 | 58.8 | 34.72 | 20.85 | 58.9 | 34.72 | 20.91 | 59.1 | 34.72 | 20.96 | 59.2 | 34.72 | 21.01 | 59.4 | 34.72 | 21.06 | 59.5 | 34.72 | 21.11 | 59.7 | 34.72 | 21.17 | 59.8 | 34.72 | 21.22 | | | | | | |
| 13.40 | 58.5 | 34.76 | 20.72 | 58.6 | 34.76 | 20.77 | 58.8 | 34.76 | 20.82 | 58.9 | 34.76 | 20.87 | 59.1 | 34.76 | 20.92 | 59.2 | 34.76 | 20.98 | 59.4 | 34.76 | 21.03 | 59.5 | 34.76 | 21.08 | 59.7 | 34.76 | 21.13 | 59.8 | 34.76 | 21.19 | | | | | | |
| 13.50 | 58.5 | 34.80 | 20.68 | 58.7 | 34.80 | 20.73 | 58.8 | 34.80 | 20.79 | 59.0 | 34.80 | 20.84 | 59.1 | 34.80 | 20.89 | 59.3 | 34.80 | 20.94 | 59.4 | 34.80 | 21.00 | 59.6 | 34.80 | 21.05 | 59.7 | 34.80 | 21.10 | 59.9 | 34.80 | 21.15 | | | | | | |
| 13.60 | 58.5 | 34.84 | 20.65 | 58.7 | 34.84 | 20.70 | 58.8 | 34.84 | 20.75 | 59.0 | 34.84 | 20.80 | 59.1 | 34.84 | 20.86 | 59.3 | 34.84 | 20.91 | 59.4 | 34.84 | 20.96 | 59.6 | 34.84 | 21.01 | 59.7 | 34.84 | 21.07 | 59.9 | 34.84 | 21.12 | | | | | | |
| 13.70 | 58.5 | 34.88 | 20.61 | 58.7 | 34.88 | 20.67 | 58.8 | 34.88 | 20.72 | 59.0 | 34.88 | 20.77 | 59.1 | 34.88 | 20.82 | 59.3 | 34.88 | 20.88 | 59.4 | 34.88 | 20.93 | 59.6 | 34.88 | 20.98 | 59.7 | 34.88 | 21.03 | 59.9 | 34.88 | 21.08 | | | | | | |
| 13.80 | 58.6 | 34.92 | 20.58 | 58.7 | 34.92 | 20.63 | 58.9 | 34.92 | 20.68 | 59.0 | 34.92 | 20.74 | 59.2 | 34.92 | 20.79 | 59.3 | 34.92 | 20.84 | 59.5 | 34.92 | 20.89 | 59.6 | 34.92 | 20.95 | 59.8 | 34.92 | 21.00 | 59.9 | 34.92 | 21.05 | | | | | | |
| 13.90 | 58.6 | 34.96 | 20.54 | 58.7 | 34.96 | 20.60 | 58.9 | 34.96 | 20.65 | 59.0 | 34.96 | 20.70 | 59.2 | 34.96 | 20.75 | 59.3 | 34.96 | 20.81 | 59.5 | 34.96 | 20.86 | 59.6 | 34.96 | 20.91 | 59.8 | 34.96 | 20.96 | 59.9 | 34.96 | 21.02 | | | | | | |
| 14.00 | 58.6 | 35.00 | 20.51 | 58.8 | 35.00 | 20.56 | 58.9 | 35.00 | 20.62 | 59.1 | 35.00 | 20.67 | 59.2 | 35.00 | 20.72 | 59.4 | 35.00 | 20.77 | 59.5 | 35.00 | 20.83 | 59.7 | 35.00 | 20.88 | 59.8 | 35.00 | 20.93 | 60.0 | 35.00 | 20.98 | | | | | | |
| 14.10 | 58.6 | 35.04 | 20.48 | 58.8 | 35.04 | 20.53 | 58.9 | 35.04 | 20.58 | 59.1 | 35.04 | 20.63 | 59.2 | 35.04 | 20.69 | 59.4 | 35.04 | 20.74 | 59.5 | 35.04 | 20.79 | 59.7 | 35.04 | 20.84 | 59.8 | 35.04 | 20.90 | 60.0 | 35.04 | 20.95 | | | | | | |
| 14.20 | 58.6 | 35.08 | 20.44 | 58.8 | 35.08 | 20.49 | 58.9 | 35.08 | 20.55 | 59.1 | 35.08 | 20.60 | 59.2 | 35.08 | 20.65 | 59.4 | 35.08 | 20.70 | 59.5 | 35.08 | 20.76 | 59.7 | 35.08 | 20.81 | 59.8 | 35.08 | 20.86 | 60.0 | 35.08 | 20.91 | | | | | | |
| 14.30 | 58.7 | 35.12 | 20.41 | 58.8 | 35.12 | 20.46 | 59.0 | 35.12 | 20.51 | 59.1 | 35.12 | 20.56 | 59.3 | 35.12 | 20.62 | 59.4 | 35.12 | 20.67 | 59.6 | 35.12 | 20.72 | 59.7 | 35.12 | 20.77 | 59.9 | 35.12 | 20.83 | 60.0 | 35.12 | 20.88 | | | | | | |
| 14.40 | 58.7 | 35.16 | 20.37 | 58.8 | 35.16 | 20.42 | 59.0 | 35.16 | 20.48 | 59.1 | 35.16 | 20.53 | 59.3 | 35.16 | 20.58 | 59.4 | 35.16 | 20.63 | 59.6 | 35.16 | 20.69 | 59.7 | 35.16 | 20.74 | 59.9 | 35.16 | 20.79 | 60.0 | 35.16 | 20.85 | | | | | | |
| 14.50 | 58.7 | 35.20 | 20.34 | 58.8 | 35.20 | 20.39 | 59.0 | 35.20 | 20.44 | 59.1 | 35.20 | 20.49 | 59.3 | 35.20 | 20.55 | 59.4 | 35.20 | 20.60 | 59.6 | 35.20 | 20.65 | 59.7 | 35.20 | 20.71 | 59.9 | 35.20 | 20.76 | 60.0 | 35.20 | 20.81 | | | | | | |
| 14.60 | 58.7 | 35.25 | 20.30 | 58.9 | 35.25 | 20.35 | 59.0 | 35.25 | 20.41 | 59.2 | 35.25 | 20.46 | 59.3 | 35.25 | 20.51 | 59.5 | 35.25 | 20.57 | 59.6 | 35.25 | 20.62 | 59.8 | 35.25 | 20.67 | 59.9 | 35.25 | 20.72 | 60.1 | 35.25 | 20.78 | | | | | | |
| 14.70 | 58.7 | 35.29 | 20.27 | 58.9 | 35.29 | 20.32 | 59.0 | 35.29 | 20.37 | 59.2 | 35.29 | 20.42 | 59.3 | 35.29 | 20.48 | 59.5 | 35.29 | 20.53 | 59.6 | 35.29 | 20.58 | 59.8 | 35.29 | 20.64 | 59.9 | 35.29 | 20.69 | 60.1 | 35.29 | 20.74 | | | | | | |
| 14.80 | 58.7 | 35.33 | 20.23 | 58.9 | 35.33 | 20.28 | 59.0 | 35.33 | 20.34 | 59.2 | 35.33 | 20.39 | 59.3 | 35.33 | 20.44 | 59.5 | 35.33 | 20.50 | 59.6 | 35.33 | 20.55 | 59.8 | 35.33 | 20.60 | 60.0 | 35.33 | 20.65 | 60.1 | 35.33 | 20.71 | | | | | | |
| 14.90 | 58.8 | 35.37 | 20.20 | 58.9 | 35.37 | 20.25 | 59.1 | 35.37 | 20.30 | 59.2 | 35.37 | 20.35 | 59.4 | 35.37 | 20.41 | 59.5 | 35.37 | 20.46 | 59.7 | 35.37 | 20.51 | 59.8 | 35.37 | 20.57 | 60.0 | 35.37 | 20.62 | 60.1 | 35.37 | 20.67 | | | | | | |
| 15.00 | 58.8 | 35.41 | 20.16 | 58.9 | 35.41 | 20.21 | 59.1 | 35.41 | 20.27 | 59.2 | 35.41 | 20.32 | 59.4 | 35.41 | 20.37 | 59.5 | 35.41 | 20.43 | 59.7 | 35.41 | 20.48 | 59.8 | 35.41 | 20.53 | 60.0 | 35.41 | 20.58 | 60.1 | 35.41 | 20.64 | | | | | | |
| 15.10 | 58.8 | 35.45 | 20.12 | 58.9 | 35.45 | 20.18 | 59.1 | 35.45 | 20.23 | 59.3 | 35.45 | 20.28 | 59.4 | 35.45 | 20.34 | 59.6 | 35.45 | 20.39 | 59.7 | 35.45 | 20.44 | 59.9 | 35.45 | 20.50 | 60.0 | 35.45 | 20.55 | 60.2 | 35.45 | 20.60 | | | | | | |
| 15.20 | 58.8 | 35.50 | 20.09 | 59.0 | 35.50 | 20.14 | 59.1 | 35.50 | 20.20 | 59.3 | 35.50 | 20.25 | 59.4 | 35.50 | 20.30 | 59.6 | 35.50 | 20.36 | 59.7 | 35.50 | 20.41 | 59.9 | 35.50 | 20.46 | 60.0 | 35.50 | 20.51 | 60.2 | 35.50 | 20.57 | | | | | | |
| 15.30 | 58.8 | 35.54 | 20.05 | 59.0 | 35.54 | 20.11 | 59.1 | 35.54 | 20.16 | 59.3 | 35.54 | 20.21 | 59.4 | 35.54 | 20.27 | 59.6 | 35.54 | 20.32 | 59.7 | 35.54 | 20.37 | 59.9 | 35.54 | 20.43 | 60.0 | 35.54 | 20.48 | 60.2 | 35.54 | 20.53 | | | | | | |
| 15.40 | 58.8 | 35.58 | 20.02 | 59.0 | 35.58 | 20.07 | 59.2 | 35.58 | 20.12 | 59.3 | 35.58 | 20.18 | 59.5 | 35.58 | 20.23 | 59.6 | 35.58 | 20.28 | 59.8 | 35.58 | 20.34 | 59.9 | 35.58 | 20.39 | 60.1 | 35.58 | 20.44 | 60.2 | 35.58 | 20.50 | | | | | | |
| 15.50 | 58.9 | 35.62 | 19.98 | 59.0 | 35.62 | 20.04 | 59.2 | 35.62 | 20.09 | 59.3 | 35.62 | 20.14 | 59.5 | 35.62 | 20.20 | 59.6 | 35.62 | 20.25 | 59.8 | 35.62 | 20.30 | 59.9 | 35.62 | 20.36 | 60.1 | 35.62 | 20.41 | 60.2 | 35.62 | 20.46 | | | | | | |
| 15.60 | 58.9 | 35.66 | 19.95 | 59.0 | 35.66 | 20.00 | 59.2 | 35.66 | 20.05 | 59.3 | 35.66 | 20.11 | 59.5 | 35.66 | 20.16 | 59.6 | 35.66 | 20.21 | 59.8 | 35.66 | 20.27 | 60.0 | 35.66 | 20.32 | 60.1 | 35.66 | 20.37 | 60.3 | 35.66 | 20.43 | | | | | | |
| 15.70 | 58.9 | 35.71 | 19.91 | 59.1 | 35.71 | 19.96 | 59.2 | 35.71 | 20.02 | 59.4 | 35.71 | 20.07 | 59.5 | 35.71 | 20.12 | 59.7 | 35.71 | 20.18 | 59.8 | 35.71 | 20.23 | 60.0 | 35.71 | 20.28 | 60.1 | 35.71 | 20.34 | 60.3 | 35.71 | 20.39 | | | | | | |
| 15.80 | 58.9 | 35.75 | 19.87 | 59.1 | 35.75 | 19.93 | 59.2 | 35.75 | 19.98 | 59.4 | 35.75 | 20.03 | 59.5 | 35.75 | 20.09 | 59.7 | 35.75 | 20.14 | 59.8 | 35.75 | 20.20 | 60.0 | 35.75 | 20.25 | 60.1 | 35.75 | 20.30 | 60.3 | 35.75 | 20.36 | | | | | | |
| 15.90 | 58.9 | 35.79 | 19.84 | 59.1 | 35.79 | 19.89 | 59.2 | 35.79 | 19.95 | 59.4 | 35.79 | 20.00 | 59.6 | 35.79 | 20.05 | 59.7 | 35.79 | 20.11 | 59.9 | 35.79 | 20.16 | 60.0 | 35.79 | 20.21 | 60.2 | 35.79 | 20.27 | 60.3 | 35.79 | 20.32 | | | | | | |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 35.0; Water (ml) = (% Absorption x 35.0 / 100) + (35.0 - sample weight)

## 35-gram Mixograph: Absorption, Flour and Water Amount Table
## (11.0 - 11.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 11.00 | | | 11.10 | | | 11.20 | | | 11.30 | | | 11.40 | | | 11.50 | | | 11.60 | | | 11.70 | | | 11.80 | | | 11.90 | | | | | | | | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | | | | | | |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | | | | | | |
| 9.00 | 59.2 | 33.08 | 22.64 | 59.3 | 33.08 | 22.69 | 59.5 | 33.08 | 22.74 | 59.6 | 33.08 | 22.79 | 59.8 | 33.08 | 22.84 | 59.9 | 33.08 | 22.89 | 60.0 | 33.08 | 22.94 | 60.2 | 33.08 | 22.99 | 60.3 | 33.08 | 23.04 | 60.5 | 33.08 | 23.09 | | | | | | |
| 9.10 | 59.2 | 33.11 | 22.61 | 59.4 | 33.11 | 22.66 | 59.5 | 33.11 | 22.71 | 59.6 | 33.11 | 22.76 | 59.8 | 33.11 | 22.81 | 59.9 | 33.11 | 22.86 | 60.1 | 33.11 | 22.91 | 60.2 | 33.11 | 22.96 | 60.3 | 33.11 | 23.01 | 60.5 | 33.11 | 23.06 | | | | | | |
| 9.20 | 59.2 | 33.15 | 22.58 | 59.4 | 33.15 | 22.63 | 59.5 | 33.15 | 22.68 | 59.7 | 33.15 | 22.73 | 59.8 | 33.15 | 22.78 | 59.9 | 33.15 | 22.83 | 60.1 | 33.15 | 22.88 | 60.2 | 33.15 | 22.93 | 60.4 | 33.15 | 22.98 | 60.5 | 33.15 | 23.03 | | | | | | |
| 9.30 | 59.2 | 33.19 | 22.55 | 59.4 | 33.19 | 22.60 | 59.5 | 33.19 | 22.65 | 59.7 | 33.19 | 22.70 | 59.8 | 33.19 | 22.75 | 60.0 | 33.19 | 22.80 | 60.1 | 33.19 | 22.85 | 60.2 | 33.19 | 22.90 | 60.4 | 33.19 | 22.95 | 60.5 | 33.19 | 23.00 | | | | | | |
| 9.40 | 59.3 | 33.22 | 22.52 | 59.4 | 33.22 | 22.57 | 59.5 | 33.22 | 22.62 | 59.7 | 33.22 | 22.67 | 59.8 | 33.22 | 22.72 | 60.0 | 33.22 | 22.77 | 60.1 | 33.22 | 22.82 | 60.3 | 33.22 | 22.87 | 60.4 | 33.22 | 22.92 | 60.5 | 33.22 | 22.97 | | | | | | |
| 9.50 | 59.3 | 33.26 | 22.49 | 59.4 | 33.26 | 22.54 | 59.6 | 33.26 | 22.59 | 59.7 | 33.26 | 22.64 | 59.8 | 33.26 | 22.69 | 60.0 | 33.26 | 22.74 | 60.1 | 33.26 | 22.79 | 60.3 | 33.26 | 22.84 | 60.4 | 33.26 | 22.89 | 60.6 | 33.26 | 22.94 | | | | | | |
| 9.60 | 59.3 | 33.30 | 22.46 | 59.4 | 33.30 | 22.51 | 59.6 | 33.30 | 22.56 | 59.7 | 33.30 | 22.61 | 59.9 | 33.30 | 22.66 | 60.0 | 33.30 | 22.71 | 60.2 | 33.30 | 22.76 | 60.3 | 33.30 | 22.81 | 60.4 | 33.30 | 22.86 | 60.6 | 33.30 | 22.91 | | | | | | |
| 9.70 | 59.3 | 33.33 | 22.43 | 59.5 | 33.33 | 22.48 | 59.6 | 33.33 | 22.53 | 59.7 | 33.33 | 22.58 | 59.9 | 33.33 | 22.63 | 60.0 | 33.33 | 22.68 | 60.2 | 33.33 | 22.73 | 60.3 | 33.33 | 22.78 | 60.5 | 33.33 | 22.83 | 60.6 | 33.33 | 22.88 | | | | | | |
| 9.80 | 59.3 | 33.37 | 22.40 | 59.5 | 33.37 | 22.45 | 59.6 | 33.37 | 22.50 | 59.8 | 33.37 | 22.55 | 59.9 | 33.37 | 22.60 | 60.0 | 33.37 | 22.65 | 60.2 | 33.37 | 22.70 | 60.3 | 33.37 | 22.75 | 60.5 | 33.37 | 22.80 | 60.6 | 33.37 | 22.85 | | | | | | |
| 9.90 | 59.3 | 33.41 | 22.36 | 59.5 | 33.41 | 22.41 | 59.6 | 33.41 | 22.47 | 59.8 | 33.41 | 22.52 | 59.9 | 33.41 | 22.57 | 60.1 | 33.41 | 22.62 | 60.2 | 33.41 | 22.67 | 60.4 | 33.41 | 22.72 | 60.5 | 33.41 | 22.77 | 60.6 | 33.41 | 22.82 | | | | | | |
| 10.00 | 59.4 | 33.44 | 22.33 | 59.5 | 33.44 | 22.38 | 59.7 | 33.44 | 22.43 | 59.8 | 33.44 | 22.48 | 59.9 | 33.44 | 22.53 | 60.1 | 33.44 | 22.58 | 60.2 | 33.44 | 22.63 | 60.4 | 33.44 | 22.69 | 60.5 | 33.44 | 22.74 | 60.7 | 33.44 | 22.79 | | | | | | |
| 10.10 | 59.4 | 33.48 | 22.30 | 59.5 | 33.48 | 22.35 | 59.7 | 33.48 | 22.40 | 59.8 | 33.48 | 22.45 | 60.0 | 33.48 | 22.50 | 60.1 | 33.48 | 22.55 | 60.2 | 33.48 | 22.60 | 60.4 | 33.48 | 22.65 | 60.5 | 33.48 | 22.70 | 60.7 | 33.48 | 22.75 | | | | | | |
| 10.20 | 59.4 | 33.52 | 22.27 | 59.5 | 33.52 | 22.32 | 59.7 | 33.52 | 22.37 | 59.8 | 33.52 | 22.42 | 60.0 | 33.52 | 22.47 | 60.1 | 33.52 | 22.52 | 60.3 | 33.52 | 22.57 | 60.4 | 33.52 | 22.62 | 60.6 | 33.52 | 22.67 | 60.7 | 33.52 | 22.72 | | | | | | |
| 10.30 | 59.4 | 33.56 | 22.24 | 59.6 | 33.56 | 22.29 | 59.7 | 33.56 | 22.34 | 59.9 | 33.56 | 22.39 | 60.0 | 33.56 | 22.44 | 60.1 | 33.56 | 22.49 | 60.3 | 33.56 | 22.54 | 60.4 | 33.56 | 22.59 | 60.6 | 33.56 | 22.64 | 60.7 | 33.56 | 22.69 | | | | | | |
| 10.40 | 59.4 | 33.59 | 22.21 | 59.6 | 33.59 | 22.26 | 59.7 | 33.59 | 22.31 | 59.9 | 33.59 | 22.36 | 60.0 | 33.59 | 22.41 | 60.2 | 33.59 | 22.46 | 60.3 | 33.59 | 22.51 | 60.4 | 33.59 | 22.56 | 60.6 | 33.59 | 22.61 | 60.7 | 33.59 | 22.66 | | | | | | |
| 10.50 | 59.5 | 33.63 | 22.18 | 59.6 | 33.63 | 22.23 | 59.7 | 33.63 | 22.28 | 59.9 | 33.63 | 22.33 | 60.0 | 33.63 | 22.38 | 60.2 | 33.63 | 22.43 | 60.3 | 33.63 | 22.48 | 60.5 | 33.63 | 22.53 | 60.6 | 33.63 | 22.58 | 60.8 | 33.63 | 22.63 | | | | | | |
| 10.60 | 59.5 | 33.67 | 22.15 | 59.6 | 33.67 | 22.20 | 59.8 | 33.67 | 22.25 | 59.9 | 33.67 | 22.30 | 60.0 | 33.67 | 22.35 | 60.2 | 33.67 | 22.40 | 60.3 | 33.67 | 22.45 | 60.5 | 33.67 | 22.50 | 60.6 | 33.67 | 22.55 | 60.8 | 33.67 | 22.60 | | | | | | |
| 10.70 | 59.5 | 33.71 | 22.11 | 59.6 | 33.71 | 22.17 | 59.8 | 33.71 | 22.22 | 59.9 | 33.71 | 22.27 | 60.1 | 33.71 | 22.32 | 60.2 | 33.71 | 22.37 | 60.4 | 33.71 | 22.42 | 60.5 | 33.71 | 22.47 | 60.6 | 33.71 | 22.52 | 60.8 | 33.71 | 22.57 | | | | | | |
| 10.80 | 59.5 | 33.74 | 22.08 | 59.7 | 33.74 | 22.13 | 59.8 | 33.74 | 22.18 | 59.9 | 33.74 | 22.24 | 60.1 | 33.74 | 22.29 | 60.2 | 33.74 | 22.34 | 60.4 | 33.74 | 22.39 | 60.5 | 33.74 | 22.44 | 60.7 | 33.74 | 22.49 | 60.8 | 33.74 | 22.54 | | | | | | |
| 10.90 | 59.5 | 33.78 | 22.05 | 59.7 | 33.78 | 22.10 | 59.8 | 33.78 | 22.15 | 60.0 | 33.78 | 22.20 | 60.1 | 33.78 | 22.25 | 60.2 | 33.78 | 22.31 | 60.4 | 33.78 | 22.36 | 60.5 | 33.78 | 22.41 | 60.7 | 33.78 | 22.46 | 60.8 | 33.78 | 22.51 | | | | | | |
| 11.00 | 59.5 | 33.82 | 22.02 | 59.7 | 33.82 | 22.07 | 59.8 | 33.82 | 22.12 | 60.0 | 33.82 | 22.17 | 60.1 | 33.82 | 22.22 | 60.3 | 33.82 | 22.27 | 60.4 | 33.82 | 22.32 | 60.6 | 33.82 | 22.38 | 60.7 | 33.82 | 22.43 | 60.8 | 33.82 | 22.48 | | | | | | |
| 11.10 | 59.6 | 33.86 | 21.99 | 59.7 | 33.86 | 22.04 | 59.9 | 33.86 | 22.09 | 60.0 | 33.86 | 22.14 | 60.1 | 33.86 | 22.19 | 60.3 | 33.86 | 22.24 | 60.4 | 33.86 | 22.29 | 60.6 | 33.86 | 22.34 | 60.7 | 33.86 | 22.39 | 60.9 | 33.86 | 22.45 | | | | | | |
| 11.20 | 59.6 | 33.90 | 21.96 | 59.7 | 33.90 | 22.01 | 59.9 | 33.90 | 22.06 | 60.0 | 33.90 | 22.11 | 60.2 | 33.90 | 22.16 | 60.3 | 33.90 | 22.21 | 60.5 | 33.90 | 22.26 | 60.6 | 33.90 | 22.31 | 60.7 | 33.90 | 22.36 | 60.9 | 33.90 | 22.41 | | | | | | |
| 11.30 | 59.6 | 33.93 | 21.92 | 59.7 | 33.93 | 21.98 | 59.9 | 33.93 | 22.03 | 60.0 | 33.93 | 22.08 | 60.2 | 33.93 | 22.13 | 60.3 | 33.93 | 22.18 | 60.5 | 33.93 | 22.23 | 60.6 | 33.93 | 22.28 | 60.8 | 33.93 | 22.33 | 60.9 | 33.93 | 22.38 | | | | | | |
| 11.40 | 59.6 | 33.97 | 21.89 | 59.8 | 33.97 | 21.94 | 59.9 | 33.97 | 21.99 | 60.1 | 33.97 | 22.05 | 60.2 | 33.97 | 22.10 | 60.3 | 33.97 | 22.15 | 60.5 | 33.97 | 22.20 | 60.6 | 33.97 | 22.25 | 60.8 | 33.97 | 22.30 | 60.9 | 33.97 | 22.35 | | | | | | |
| 11.50 | 59.6 | 34.01 | 21.86 | 59.8 | 34.01 | 21.91 | 59.9 | 34.01 | 21.96 | 60.1 | 34.01 | 22.01 | 60.2 | 34.01 | 22.06 | 60.4 | 34.01 | 22.12 | 60.5 | 34.01 | 22.17 | 60.7 | 34.01 | 22.22 | 60.8 | 34.01 | 22.27 | 60.9 | 34.01 | 22.32 | | | | | | |
| 11.60 | 59.7 | 34.05 | 21.83 | 59.8 | 34.05 | 21.88 | 59.9 | 34.05 | 21.93 | 60.1 | 34.05 | 21.98 | 60.2 | 34.05 | 22.03 | 60.4 | 34.05 | 22.08 | 60.5 | 34.05 | 22.13 | 60.7 | 34.05 | 22.19 | 60.8 | 34.05 | 22.24 | 61.0 | 34.05 | 22.29 | | | | | | |
| 11.70 | 59.7 | 34.09 | 21.80 | 59.8 | 34.09 | 21.85 | 60.0 | 34.09 | 21.90 | 60.1 | 34.09 | 21.95 | 60.3 | 34.09 | 22.00 | 60.4 | 34.09 | 22.05 | 60.5 | 34.09 | 22.10 | 60.7 | 34.09 | 22.15 | 60.8 | 34.09 | 22.21 | 61.0 | 34.09 | 22.26 | | | | | | |
| 11.80 | 59.7 | 34.13 | 21.76 | 59.8 | 34.13 | 21.82 | 60.0 | 34.13 | 21.87 | 60.1 | 34.13 | 21.92 | 60.3 | 34.13 | 21.97 | 60.4 | 34.13 | 22.02 | 60.6 | 34.13 | 22.07 | 60.7 | 34.13 | 22.12 | 60.9 | 34.13 | 22.17 | 61.0 | 34.13 | 22.22 | | | | | | |
| 11.90 | 59.7 | 34.17 | 21.73 | 59.9 | 34.17 | 21.78 | 60.0 | 34.17 | 21.83 | 60.1 | 34.17 | 21.89 | 60.3 | 34.17 | 21.94 | 60.4 | 34.17 | 21.99 | 60.6 | 34.17 | 22.04 | 60.7 | 34.17 | 22.09 | 60.9 | 34.17 | 22.14 | 61.0 | 34.17 | 22.19 | | | | | | |
| 12.00 | 59.7 | 34.20 | 21.70 | 59.9 | 34.20 | 21.75 | 60.0 | 34.20 | 21.80 | 60.2 | 34.20 | 21.85 | 60.3 | 34.20 | 21.90 | 60.5 | 34.20 | 21.96 | 60.6 | 34.20 | 22.01 | 60.8 | 34.20 | 22.06 | 60.9 | 34.20 | 22.11 | 61.0 | 34.20 | 22.16 | | | | | | |
| 12.10 | 59.7 | 34.24 | 21.67 | 59.9 | 34.24 | 21.72 | 60.0 | 34.24 | 21.77 | 60.2 | 34.24 | 21.82 | 60.3 | 34.24 | 21.87 | 60.5 | 34.24 | 21.92 | 60.6 | 34.24 | 21.97 | 60.8 | 34.24 | 22.03 | 60.9 | 34.24 | 22.08 | 61.1 | 34.24 | 22.13 | | | | | | |
| 12.30 | 59.8 | 34.32 | 21.60 | 59.9 | 34.32 | 21.65 | 60.1 | 34.32 | 21.70 | 60.2 | 34.32 | 21.76 | 60.4 | 34.32 | 21.81 | 60.5 | 34.32 | 21.86 | 60.7 | 34.32 | 21.91 | 60.8 | 34.32 | 21.96 | 61.0 | 34.32 | 22.01 | 61.1 | 34.32 | 22.06 | | | | | | |
| 12.30 | 59.8 | 34.32 | 21.60 | 59.9 | 34.32 | 21.65 | 60.1 | 34.32 | 21.70 | 60.2 | 34.32 | 21.76 | 60.4 | 34.32 | 21.81 | 60.5 | 34.32 | 21.86 | 60.7 | 34.32 | 21.91 | 60.8 | 34.32 | 21.96 | 61.0 | 34.32 | 22.01 | 61.1 | 34.32 | 22.06 | | | | | | |
| 12.40 | 59.8 | 34.36 | 21.57 | 59.9 | 34.36 | 21.62 | 60.1 | 34.36 | 21.67 | 60.2 | 34.36 | 21.72 | 60.4 | 34.36 | 21.77 | 60.5 | 34.36 | 21.83 | 60.7 | 34.36 | 21.88 | 60.8 | 34.36 | 21.93 | 61.0 | 34.36 | 21.98 | 61.1 | 34.36 | 22.03 | | | | | | |
| 12.50 | 59.8 | 34.40 | 21.54 | 60.0 | 34.40 | 21.59 | 60.1 | 34.40 | 21.64 | 60.3 | 34.40 | 21.69 | 60.4 | 34.40 | 21.74 | 60.6 | 34.40 | 21.79 | 60.7 | 34.40 | 21.85 | 60.8 | 34.40 | 21.90 | 61.0 | 34.40 | 21.95 | 61.1 | 34.40 | 22.00 | | | | | | |
| 12.60 | 59.8 | 34.44 | 21.50 | 60.0 | 34.44 | 21.55 | 60.1 | 34.44 | 21.61 | 60.3 | 34.44 | 21.66 | 60.4 | 34.44 | 21.71 | 60.6 | 34.44 | 21.76 | 60.7 | 34.44 | 21.81 | 60.9 | 34.44 | 21.86 | 61.0 | 34.44 | 21.92 | 61.2 | 34.44 | 21.97 | | | | | | |
| 12.70 | 59.9 | 34.48 | 21.47 | 60.0 | 34.48 | 21.52 | 60.1 | 34.48 | 21.57 | 60.3 | 34.48 | 21.63 | 60.4 | 34.48 | 21.68 | 60.6 | 34.48 | 21.73 | 60.7 | 34.48 | 21.78 | 60.9 | 34.48 | 21.83 | 61.0 | 34.48 | 21.88 | 61.2 | 34.48 | 21.94 | | | | | | |
| 12.80 | 59.9 | 34.52 | 21.44 | 60.0 | 34.52 | 21.49 | 60.2 | 34.52 | 21.54 | 60.3 | 34.52 | 21.59 | 60.5 | 34.52 | 21.64 | 60.6 | 34.52 | 21.70 | 60.8 | 34.52 | 21.75 | 60.9 | 34.52 | 21.80 | 61.1 | 34.52 | 21.85 | 61.2 | 34.52 | 21.90 | | | | | | |
| 12.90 | 59.9 | 34.56 | 21.40 | 60.0 | 34.56 | 21.46 | 60.2 | 34.56 | 21.51 | 60.3 | 34.56 | 21.56 | 60.5 | 34.56 | 21.61 | 60.6 | 34.56 | 21.66 | 60.8 | 34.56 | 21.72 | 60.9 | 34.56 | 21.77 | 61.1 | 34.56 | 21.82 | 61.2 | 34.56 | 21.87 | | | | | | |
| 13.00 | 59.9 | 34.60 | 21.37 | 60.1 | 34.60 | 21.42 | 60.2 | 34.60 | 21.47 | 60.4 | 34.60 | 21.53 | 60.5 | 34.60 | 21.58 | 60.7 | 34.60 | 21.63 | 60.8 | 34.60 | 21.68 | 60.9 | 34.60 | 21.73 | 61.1 | 34.60 | 21.79 | 61.2 | 34.60 | 21.84 | | | | | | |
| 13.10 | 59.9 | 34.64 | 21.34 | 60.1 | 34.64 | 21.39 | 60.2 | 34.64 | 21.44 | 60.4 | 34.64 | 21.49 | 60.5 | 34.64 | 21.55 | 60.7 | 34.64 | 21.60 | 60.8 | 34.64 | 21.65 | 61.0 | 34.64 | 21.70 | 61.1 | 34.64 | 21.75 | 61.3 | 34.64 | 21.81 | | | | | | |
| 13.20 | 59.9 | 34.68 | 21.30 | 60.1 | 34.68 | 21.36 | 60.2 | 34.68 | 21.41 | 60.4 | 34.68 | 21.46 | 60.5 | 34.68 | 21.51 | 60.7 | 34.68 | 21.56 | 60.8 | 34.68 | 21.62 | 61.0 | 34.68 | 21.67 | 61.1 | 34.68 | 21.72 | 61.3 | 34.68 | 21.77 | | | | | | |
| 13.30 | 60.0 | 34.72 | 21.27 | 60.1 | 34.72 | 21.32 | 60.3 | 34.72 | 21.38 | 60.4 | 34.72 | 21.43 | 60.6 | 34.72 | 21.48 | 60.7 | 34.72 | 21.53 | 60.9 | 34.72 | 21.58 | 61.0 | 34.72 | 21.64 | 61.2 | 34.72 | 21.69 | 61.3 | 34.72 | 21.74 | | | | | | |
| 13.40 | 60.0 | 34.76 | 21.24 | 60.1 | 34.76 | 21.29 | 60.3 | 34.76 | 21.34 | 60.4 | 34.76 | 21.39 | 60.6 | 34.76 | 21.45 | 60.7 | 34.76 | 21.50 | 60.9 | 34.76 | 21.55 | 61.0 | 34.76 | 21.60 | 61.2 | 34.76 | 21.65 | 61.3 | 34.76 | 21.71 | | | | | | |
| 13.50 | 60.0 | 34.80 | 21.20 | 60.2 | 34.80 | 21.26 | 60.3 | 34.80 | 21.31 | 60.5 | 34.80 | 21.36 | 60.6 | 34.80 | 21.41 | 60.8 | 34.80 | 21.46 | 60.9 | 34.80 | 21.52 | 61.0 | 34.80 | 21.57 | 61.2 | 34.80 | 21.62 | 61.3 | 34.80 | 21.67 | | | | | | |
| 13.60 | 60.0 | 34.84 | 21.17 | 60.2 | 34.84 | 21.22 | 60.3 | 34.84 | 21.27 | 60.5 | 34.84 | 21.33 | 60.6 | 34.84 | 21.38 | 60.8 | 34.84 | 21.43 | 60.9 | 34.84 | 21.48 | 61.1 | 34.84 | 21.54 | 61.2 | 34.84 | 21.59 | 61.4 | 34.84 | 21.64 | | | | | | |
| 13.70 | 60.0 | 34.88 | 21.14 | 60.2 | 34.88 | 21.19 | 60.3 | 34.88 | 21.24 | 60.5 | 34.88 | 21.29 | 60.6 | 34.88 | 21.35 | 60.8 | 34.88 | 21.40 | 60.9 | 34.88 | 21.45 | 61.1 | 34.88 | 21.50 | 61.2 | 34.88 | 21.56 | 61.4 | 34.88 | 21.61 | | | | | | |
| 13.80 | 60.1 | 34.92 | 21.10 | 60.2 | 34.92 | 21.16 | 60.4 | 34.92 | 21.21 | 60.5 | 34.92 | 21.26 | 60.7 | 34.92 | 21.31 | 60.8 | 34.92 | 21.36 | 61.0 | 34.92 | 21.42 | 61.1 | 34.92 | 21.47 | 61.3 | 34.92 | 21.52 | 61.4 | 34.92 | 21.57 | | | | | | |
| 13.90 | 60.1 | 34.96 | 21.07 | 60.2 | 34.96 | 21.12 | 60.4 | 34.96 | 21.17 | 60.5 | 34.96 | 21.23 | 60.7 | 34.96 | 21.28 | 60.8 | 34.96 | 21.33 | 61.0 | 34.96 | 21.38 | 61.1 | 34.96 | 21.44 | 61.3 | 34.96 | 21.49 | 61.4 | 34.96 | 21.54 | | | | | | |
| 14.00 | 60.1 | 35.00 | 21.04 | 60.3 | 35.00 | 21.09 | 60.4 | 35.00 | 21.14 | 60.6 | 35.00 | 21.19 | 60.7 | 35.00 | 21.25 | 60.9 | 35.00 | 21.30 | 61.0 | 35.00 | 21.35 | 61.2 | 35.00 | 21.40 | 61.3 | 35.00 | 21.46 | 61.5 | 35.00 | 21.51 | | | | | | |
| 14.10 | 60.1 | 35.04 | 21.00 | 60.3 | 35.04 | 21.05 | 60.4 | 35.04 | 21.11 | 60.6 | 35.04 | 21.16 | 60.7 | 35.04 | 21.21 | 60.9 | 35.04 | 21.26 | 61.0 | 35.04 | 21.32 | 61.2 | 35.04 | 21.37 | 61.3 | 35.04 | 21.42 | 61.5 | 35.04 | 21.47 | | | | | | |
| 14.20 | 60.1 | 35.08 | 20.97 | 60.3 | 35.08 | 21.02 | 60.4 | 35.08 | 21.07 | 60.6 | 35.08 | 21.12 | 60.7 | 35.08 | 21.18 | 60.9 | 35.08 | 21.23 | 61.0 | 35.08 | 21.28 | 61.2 | 35.08 | 21.34 | 61.3 | 35.08 | 21.39 | 61.5 | 35.08 | 21.44 | | | | | | |
| 14.30 | 60.2 | 35.12 | 20.93 | 60.3 | 35.12 | 20.99 | 60.5 | 35.12 | 21.04 | 60.6 | 35.12 | 21.09 | 60.8 | 35.12 | 21.14 | 60.9 | 35.12 | 21.20 | 61.1 | 35.12 | 21.25 | 61.2 | 35.12 | 21.30 | 61.4 | 35.12 | 21.35 | 61.5 | 35.12 | 21.41 | | | | | | |
| 14.40 | 60.2 | 35.16 | 20.90 | 60.3 | 35.16 | 20.95 | 60.5 | 35.16 | 21.00 | 60.6 | 35.16 | 21.06 | 60.8 | 35.16 | 21.11 | 60.9 | 35.16 | 21.16 | 61.1 | 35.16 | 21.21 | 61.2 | 35.16 | 21.27 | 61.4 | 35.16 | 21.32 | 61.5 | 35.16 | 21.37 | | | | | | |
| 14.50 | 60.2 | 35.20 | 20.86 | 60.3 | 35.20 | 20.92 | 60.5 | 35.20 | 20.97 | 60.6 | 35.20 | 21.02 | 60.8 | 35.20 | 21.08 | 61.0 | 35.20 | 21.13 | 61.1 | 35.20 | 21.18 | 61.3 | 35.20 | 21.23 | 61.4 | 35.20 | 21.29 | 61.6 | 35.20 | 21.34 | | | | | | |
| 14.60 | 60.2 | 35.25 | 20.83 | 60.4 | 35.25 | 20.88 | 60.5 | 35.25 | 20.94 | 60.7 | 35.25 | 20.99 | 60.8 | 35.25 | 21.04 | 61.0 | 35.25 | 21.09 | 61.1 | 35.25 | 21.15 | 61.3 | 35.25 | 21.20 | 61.4 | 35.25 | 21.25 | 61.6 | 35.25 | 21.31 | | | | | | |
| 14.70 | 60.2 | 35.29 | 20.80 | 60.4 | 35.29 | 20.85 | 60.5 | 35.29 | 20.90 | 60.7 | 35.29 | 20.95 | 60.8 | 35.29 | 21.01 | 61.0 | 35.29 | 21.06 | 61.1 | 35.29 | 21.11 | 61.3 | 35.29 | 21.17 | 61.4 | 35.29 | 21.22 | 61.6 | 35.29 | 21.27 | | | | | | |
| 14.80 | 60.3 | 35.33 | 20.76 | 60.4 | 35.33 | 20.81 | 60.6 | 35.33 | 20.87 | 60.7 | 35.33 | 20.92 | 60.9 | 35.33 | 20.97 | 61.0 | 35.33 | 21.03 | 61.2 | 35.33 | 21.08 | 61.3 | 35.33 | 21.13 | 61.5 | 35.33 | 21.18 | 61.6 | 35.33 | 21.24 | | | | | | |
| 14.90 | 60.3 | 35.37 | 20.73 | 60.4 | 35.37 | 20.78 | 60.6 | 35.37 | 20.83 | 60.7 | 35.37 | 20.89 | 60.9 | 35.37 | 20.94 | 61.0 | 35.37 | 20.99 | 61.2 | 35.37 | 21.04 | 61.3 | 35.37 | 21.10 | 61.5 | 35.37 | 21.15 | 61.6 | 35.37 | 21.20 | | | | | | |
| 15.00 | 60.3 | 35.41 | 20.69 | 60.4 | 35.41 | 20.74 | 60.6 | 35.41 | 20.80 | 60.7 | 35.41 | 20.85 | 60.9 | 35.41 | 20.90 | 61.1 | 35.41 | 20.96 | 61.2 | 35.41 | 21.01 | 61.4 | 35.41 | 21.06 | 61.5 | 35.41 | 21.12 | 61.7 | 35.41 | 21.17 | | | | | | |
| 15.10 | 60.3 | 35.45 | 20.66 | 60.5 | 35.45 | 20.71 | 60.6 | 35.45 | 20.76 | 60.8 | 35.45 | 20.82 | 60.9 | 35.45 | 20.87 | 61.1 | 35.45 | 20.92 | 61.2 | 35.45 | 20.98 | 61.4 | 35.45 | 21.03 | 61.5 | 35.45 | 21.08 | 61.7 | 35.45 | 21.13 | | | | | | |
| 15.20 | 60.3 | 35.50 | 20.62 | 60.5 | 35.50 | 20.67 | 60.6 | 35.50 | 20.73 | 60.8 | 35.50 | 20.78 | 60.9 | 35.50 | 20.83 | 61.1 | 35.50 | 20.89 | 61.2 | 35.50 | 20.94 | 61.4 | 35.50 | 20.99 | 61.6 | 35.50 | 21.05 | 61.7 | 35.50 | 21.10 | | | | | | |
| 15.30 | 60.4 | 35.54 | 20.59 | 60.5 | 35.54 | 20.64 | 60.7 | 35.54 | 20.69 | 60.8 | 35.54 | 20.75 | 61.0 | 35.54 | 20.80 | 61.1 | 35.54 | 20.85 | 61.3 | 35.54 | 20.91 | 61.4 | 35.54 | 20.96 | 61.6 | 35.54 | 21.01 | 61.7 | 35.54 | 21.07 | | | | | | |
| 15.40 | 60.4 | 35.58 | 20.55 | 60.5 | 35.58 | 20.60 | 60.7 | 35.58 | 20.66 | 60.8 | 35.58 | 20.71 | 61.0 | 35.58 | 20.76 | 61.1 | 35.58 | 20.82 | 61.3 | 35.58 | 20.87 | 61.4 | 35.58 | 20.92 | 61.6 | 35.58 | 20.98 | 61.7 | 35.58 | 21.03 | | | | | | |
| 15.50 | 60.4 | 35.62 | 20.52 | 60.5 | 35.62 | 20.57 | 60.7 | 35.62 | 20.62 | 60.9 | 35.62 | 20.68 | 61.0 | 35.62 | 20.73 | 61.2 | 35.62 | 20.78 | 61.3 | 35.62 | 20.84 | 61.5 | 35.62 | 20.89 | 61.6 | 35.62 | 20.94 | 61.8 | 35.62 | 21.00 | | | | | | |
| 15.60 | 60.4 | 35.66 | 20.48 | 60.6 | 35.66 | 20.53 | 60.7 | 35.66 | 20.59 | 60.9 | 35.66 | 20.64 | 61.0 | 35.66 | 20.69 | 61.2 | 35.66 | 20.75 | 61.3 | 35.66 | 20.80 | 61.5 | 35.66 | 20.86 | 61.6 | 35.66 | 20.91 | 61.8 | 35.66 | 20.96 | | | | | | |
| 15.70 | 60.4 | 35.71 | 20.45 | 60.6 | 35.71 | 20.50 | 60.7 | 35.71 | 20.55 | 60.9 | 35.71 | 20.61 | 61.0 | 35.71 | 20.66 | 61.2 | 35.71 | 20.71 | 61.4 | 35.71 | 20.77 | 61.5 | 35.71 | 20.82 | 61.7 | 35.71 | 20.87 | 61.8 | 35.71 | 20.93 | | | | | | |
| 15.80 | 60.5 | 35.75 | 20.41 | 60.6 | 35.75 | 20.46 | 60.8 | 35.75 | 20.52 | 60.9 | 35.75 | 20.57 | 61.1 | 35.75 | 20.62 | 61.2 | 35.75 | 20.68 | 61.4 | 35.75 | 20.73 | 61.5 | 35.75 | 20.79 | 61.7 | 35.75 | 20.84 | 61.8 | 35.75 | 20.89 | | | | | | |
| 15.90 | 60.5 | 35.79 | 20.37 | 60.6 | 35.79 | 20.43 | 60.8 | 35.79 | 20.48 | 60.9 | 35.79 | 20.54 | 61.1 | 35.79 | 20.59 | 61.2 | 35.79 | 20.64 | 61.4 | 35.79 | 20.70 | 61.5 | 35.79 | 20.75 | 61.7 | 35.79 | 20.80 | 61.9 | 35.79 | 20.86 | | | | | | |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 35.0; Water (ml) = (% Absorption x 35.0 / 100) + (35.0 - sample weight)

## 35-gram Mixograph: Absorption, Flour and Water Amount Table
## (12.0 - 12.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 12.00 | | | 12.10 | | | 12.20 | | | 12.30 | | | 12.40 | | | 12.50 | | | 12.60 | | | 12.70 | | | 12.80 | | | 12.90 | | | | | | | | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | | | | | | |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | | | | | | |
| 9.00 | 60.6 | 33.08 | 23.14 | 60.8 | 33.08 | 23.19 | 60.9 | 33.08 | 23.24 | 61.0 | 33.08 | 23.29 | 61.2 | 33.08 | 23.34 | 61.3 | 33.08 | 23.39 | 61.5 | 33.08 | 23.43 | 61.6 | 33.08 | 23.48 | 61.7 | 33.08 | 23.53 | 61.9 | 33.08 | 23.58 | | | | | | |
| 9.10 | 60.6 | 33.11 | 23.11 | 60.8 | 33.11 | 23.16 | 60.9 | 33.11 | 23.21 | 61.1 | 33.11 | 23.26 | 61.2 | 33.11 | 23.31 | 61.3 | 33.11 | 23.36 | 61.5 | 33.11 | 23.41 | 61.6 | 33.11 | 23.45 | 61.8 | 33.11 | 23.50 | 61.9 | 33.11 | 23.55 | | | | | | |
| 9.20 | 60.6 | 33.15 | 23.08 | 60.8 | 33.15 | 23.13 | 60.9 | 33.15 | 23.18 | 61.1 | 33.15 | 23.23 | 61.2 | 33.15 | 23.28 | 61.4 | 33.15 | 23.33 | 61.5 | 33.15 | 23.38 | 61.6 | 33.15 | 23.43 | 61.8 | 33.15 | 23.47 | 61.9 | 33.15 | 23.52 | | | | | | |
| 9.30 | 60.7 | 33.19 | 23.05 | 60.8 | 33.19 | 23.10 | 61.0 | 33.19 | 23.15 | 61.1 | 33.19 | 23.20 | 61.2 | 33.19 | 23.25 | 61.4 | 33.19 | 23.30 | 61.5 | 33.19 | 23.35 | 61.7 | 33.19 | 23.40 | 61.8 | 33.19 | 23.45 | 61.9 | 33.19 | 23.50 | | | | | | |
| 9.40 | 60.7 | 33.22 | 23.02 | 60.8 | 33.22 | 23.07 | 61.0 | 33.22 | 23.12 | 61.1 | 33.22 | 23.17 | 61.3 | 33.22 | 23.22 | 61.4 | 33.22 | 23.27 | 61.5 | 33.22 | 23.32 | 61.7 | 33.22 | 23.37 | 61.8 | 33.22 | 23.42 | 62.0 | 33.22 | 23.47 | | | | | | |
| 9.50 | 60.7 | 33.26 | 22.99 | 60.8 | 33.26 | 23.04 | 61.0 | 33.26 | 23.09 | 61.1 | 33.26 | 23.14 | 61.3 | 33.26 | 23.19 | 61.4 | 33.26 | 23.24 | 61.6 | 33.26 | 23.29 | 61.7 | 33.26 | 23.34 | 61.8 | 33.26 | 23.39 | 62.0 | 33.26 | 23.44 | | | | | | |
| 9.60 | 60.7 | 33.30 | 22.96 | 60.9 | 33.30 | 23.01 | 61.0 | 33.30 | 23.06 | 61.2 | 33.30 | 23.11 | 61.3 | 33.30 | 23.16 | 61.4 | 33.30 | 23.21 | 61.6 | 33.30 | 23.26 | 61.7 | 33.30 | 23.31 | 61.9 | 33.30 | 23.36 | 62.0 | 33.30 | 23.41 | | | | | | |
| 9.70 | 60.7 | 33.33 | 22.93 | 60.9 | 33.33 | 22.98 | 61.0 | 33.33 | 23.03 | 61.2 | 33.33 | 23.08 | 61.3 | 33.33 | 23.13 | 61.5 | 33.33 | 23.18 | 61.6 | 33.33 | 23.23 | 61.7 | 33.33 | 23.28 | 61.9 | 33.33 | 23.33 | 62.0 | 33.33 | 23.38 | | | | | | |
| 9.80 | 60.8 | 33.37 | 22.90 | 60.9 | 33.37 | 22.95 | 61.0 | 33.37 | 23.00 | 61.2 | 33.37 | 23.05 | 61.3 | 33.37 | 23.10 | 61.5 | 33.37 | 23.15 | 61.6 | 33.37 | 23.20 | 61.8 | 33.37 | 23.25 | 61.9 | 33.37 | 23.30 | 62.0 | 33.37 | 23.35 | | | | | | |
| 9.90 | 60.8 | 33.41 | 22.87 | 60.9 | 33.41 | 22.92 | 61.1 | 33.41 | 22.97 | 61.2 | 33.41 | 23.02 | 61.4 | 33.41 | 23.07 | 61.5 | 33.41 | 23.12 | 61.6 | 33.41 | 23.17 | 61.8 | 33.41 | 23.22 | 61.9 | 33.41 | 23.27 | 62.1 | 33.41 | 23.32 | | | | | | |
| 10.00 | 60.8 | 33.44 | 22.84 | 60.9 | 33.44 | 22.89 | 61.1 | 33.44 | 22.94 | 61.2 | 33.44 | 22.99 | 61.4 | 33.44 | 23.04 | 61.5 | 33.44 | 23.09 | 61.7 | 33.44 | 23.14 | 61.8 | 33.44 | 23.19 | 61.9 | 33.44 | 23.24 | 62.1 | 33.44 | 23.29 | | | | | | |
| 10.10 | 60.8 | 33.48 | 22.81 | 61.0 | 33.48 | 22.86 | 61.1 | 33.48 | 22.91 | 61.2 | 33.48 | 22.96 | 61.4 | 33.48 | 23.01 | 61.5 | 33.48 | 23.06 | 61.7 | 33.48 | 23.11 | 61.8 | 33.48 | 23.16 | 62.0 | 33.48 | 23.21 | 62.1 | 33.48 | 23.26 | | | | | | |
| 10.20 | 60.8 | 33.52 | 22.77 | 61.0 | 33.52 | 22.82 | 61.1 | 33.52 | 22.88 | 61.3 | 33.52 | 22.93 | 61.4 | 33.52 | 22.98 | 61.6 | 33.52 | 23.03 | 61.7 | 33.52 | 23.08 | 61.8 | 33.52 | 23.13 | 62.0 | 33.52 | 23.18 | 62.1 | 33.52 | 23.23 | | | | | | |
| 10.30 | 60.9 | 33.56 | 22.74 | 61.0 | 33.56 | 22.79 | 61.1 | 33.56 | 22.84 | 61.3 | 33.56 | 22.89 | 61.4 | 33.56 | 22.95 | 61.6 | 33.56 | 23.00 | 61.7 | 33.56 | 23.05 | 61.9 | 33.56 | 23.10 | 62.0 | 33.56 | 23.15 | 62.2 | 33.56 | 23.20 | | | | | | |
| 10.40 | 60.9 | 33.59 | 22.71 | 61.0 | 33.59 | 22.76 | 61.2 | 33.59 | 22.81 | 61.3 | 33.59 | 22.86 | 61.5 | 33.59 | 22.91 | 61.6 | 33.59 | 22.97 | 61.7 | 33.59 | 23.02 | 61.9 | 33.59 | 23.07 | 62.0 | 33.59 | 23.12 | 62.2 | 33.59 | 23.17 | | | | | | |
| 10.50 | 60.9 | 33.63 | 22.68 | 61.0 | 33.63 | 22.73 | 61.2 | 33.63 | 22.78 | 61.3 | 33.63 | 22.83 | 61.5 | 33.63 | 22.88 | 61.6 | 33.63 | 22.93 | 61.8 | 33.63 | 22.99 | 61.9 | 33.63 | 23.04 | 62.0 | 33.63 | 23.09 | 62.2 | 33.63 | 23.14 | | | | | | |
| 10.60 | 60.9 | 33.67 | 22.65 | 61.1 | 33.67 | 22.70 | 61.2 | 33.67 | 22.75 | 61.3 | 33.67 | 22.80 | 61.5 | 33.67 | 22.85 | 61.6 | 33.67 | 22.90 | 61.8 | 33.67 | 22.95 | 61.9 | 33.67 | 23.01 | 62.1 | 33.67 | 23.06 | 62.2 | 33.67 | 23.11 | | | | | | |
| 10.70 | 60.9 | 33.71 | 22.62 | 61.1 | 33.71 | 22.67 | 61.2 | 33.71 | 22.72 | 61.4 | 33.71 | 22.77 | 61.5 | 33.71 | 22.82 | 61.7 | 33.71 | 22.87 | 61.8 | 33.71 | 22.92 | 61.9 | 33.71 | 22.97 | 62.1 | 33.71 | 23.03 | 62.2 | 33.71 | 23.08 | | | | | | |
| 10.80 | 61.0 | 33.74 | 22.59 | 61.1 | 33.74 | 22.64 | 61.2 | 33.74 | 22.69 | 61.4 | 33.74 | 22.74 | 61.5 | 33.74 | 22.79 | 61.7 | 33.74 | 22.84 | 61.8 | 33.74 | 22.89 | 62.0 | 33.74 | 22.94 | 62.1 | 33.74 | 22.99 | 62.3 | 33.74 | 23.05 | | | | | | |
| 10.90 | 61.0 | 33.78 | 22.56 | 61.1 | 33.78 | 22.61 | 61.3 | 33.78 | 22.66 | 61.4 | 33.78 | 22.71 | 61.6 | 33.78 | 22.76 | 61.7 | 33.78 | 22.81 | 61.8 | 33.78 | 22.86 | 62.0 | 33.78 | 22.91 | 62.1 | 33.78 | 22.96 | 62.3 | 33.78 | 23.01 | | | | | | |
| 11.00 | 61.0 | 33.82 | 22.53 | 61.1 | 33.82 | 22.58 | 61.3 | 33.82 | 22.63 | 61.4 | 33.82 | 22.68 | 61.6 | 33.82 | 22.73 | 61.7 | 33.82 | 22.78 | 61.9 | 33.82 | 22.83 | 62.0 | 33.82 | 22.88 | 62.2 | 33.82 | 22.93 | 62.3 | 33.82 | 22.98 | | | | | | |
| 11.10 | 61.0 | 33.86 | 22.50 | 61.2 | 33.86 | 22.55 | 61.3 | 33.86 | 22.60 | 61.4 | 33.86 | 22.65 | 61.6 | 33.86 | 22.70 | 61.7 | 33.86 | 22.75 | 61.9 | 33.86 | 22.80 | 62.0 | 33.86 | 22.85 | 62.2 | 33.86 | 22.90 | 62.3 | 33.86 | 22.95 | | | | | | |
| 11.20 | 61.0 | 33.90 | 22.46 | 61.2 | 33.90 | 22.52 | 61.3 | 33.90 | 22.57 | 61.5 | 33.90 | 22.62 | 61.6 | 33.90 | 22.67 | 61.8 | 33.90 | 22.72 | 61.9 | 33.90 | 22.77 | 62.0 | 33.90 | 22.82 | 62.2 | 33.90 | 22.87 | 62.3 | 33.90 | 22.92 | | | | | | |
| 11.30 | 61.1 | 33.93 | 22.43 | 61.2 | 33.93 | 22.48 | 61.3 | 33.93 | 22.54 | 61.5 | 33.93 | 22.59 | 61.6 | 33.93 | 22.64 | 61.8 | 33.93 | 22.69 | 61.9 | 33.93 | 22.74 | 62.1 | 33.93 | 22.79 | 62.2 | 33.93 | 22.84 | 62.4 | 33.93 | 22.89 | | | | | | |
| 11.40 | 61.1 | 33.97 | 22.40 | 61.2 | 33.97 | 22.45 | 61.4 | 33.97 | 22.50 | 61.5 | 33.97 | 22.56 | 61.7 | 33.97 | 22.61 | 61.8 | 33.97 | 22.66 | 61.9 | 33.97 | 22.71 | 62.1 | 33.97 | 22.76 | 62.2 | 33.97 | 22.81 | 62.4 | 33.97 | 22.86 | | | | | | |
| 11.50 | 61.1 | 34.01 | 22.37 | 61.2 | 34.01 | 22.42 | 61.4 | 34.01 | 22.47 | 61.5 | 34.01 | 22.52 | 61.7 | 34.01 | 22.57 | 61.8 | 34.01 | 22.63 | 62.0 | 34.01 | 22.68 | 62.1 | 34.01 | 22.73 | 62.3 | 34.01 | 22.78 | 62.4 | 34.01 | 22.83 | | | | | | |
| 11.60 | 61.1 | 34.05 | 22.34 | 61.3 | 34.05 | 22.39 | 61.4 | 34.05 | 22.44 | 61.5 | 34.05 | 22.49 | 61.7 | 34.05 | 22.54 | 61.8 | 34.05 | 22.59 | 62.0 | 34.05 | 22.65 | 62.1 | 34.05 | 22.70 | 62.3 | 34.05 | 22.75 | 62.4 | 34.05 | 22.80 | | | | | | |
| 11.70 | 61.1 | 34.09 | 22.31 | 61.3 | 34.09 | 22.36 | 61.4 | 34.09 | 22.41 | 61.6 | 34.09 | 22.46 | 61.7 | 34.09 | 22.51 | 61.9 | 34.09 | 22.56 | 62.0 | 34.09 | 22.61 | 62.2 | 34.09 | 22.67 | 62.3 | 34.09 | 22.72 | 62.4 | 34.09 | 22.77 | | | | | | |
| 11.80 | 61.2 | 34.13 | 22.28 | 61.3 | 34.13 | 22.33 | 61.4 | 34.13 | 22.38 | 61.6 | 34.13 | 22.43 | 61.7 | 34.13 | 22.48 | 61.9 | 34.13 | 22.53 | 62.0 | 34.13 | 22.58 | 62.2 | 34.13 | 22.63 | 62.3 | 34.13 | 22.69 | 62.5 | 34.13 | 22.74 | | | | | | |
| 11.90 | 61.2 | 34.17 | 22.24 | 61.3 | 34.17 | 22.30 | 61.5 | 34.17 | 22.35 | 61.6 | 34.17 | 22.40 | 61.8 | 34.17 | 22.45 | 61.9 | 34.17 | 22.50 | 62.0 | 34.17 | 22.55 | 62.2 | 34.17 | 22.60 | 62.3 | 34.17 | 22.65 | 62.5 | 34.17 | 22.71 | | | | | | |
| 12.00 | 61.2 | 34.20 | 22.21 | 61.3 | 34.20 | 22.26 | 61.5 | 34.20 | 22.31 | 61.6 | 34.20 | 22.37 | 61.8 | 34.20 | 22.42 | 61.9 | 34.20 | 22.47 | 62.1 | 34.20 | 22.52 | 62.2 | 34.20 | 22.57 | 62.4 | 34.20 | 22.62 | 62.5 | 34.20 | 22.67 | | | | | | |
| 12.10 | 61.2 | 34.24 | 22.18 | 61.4 | 34.24 | 22.23 | 61.5 | 34.24 | 22.28 | 61.7 | 34.24 | 22.33 | 61.8 | 34.24 | 22.39 | 61.9 | 34.24 | 22.44 | 62.1 | 34.24 | 22.49 | 62.2 | 34.24 | 22.54 | 62.4 | 34.24 | 22.59 | 62.5 | 34.24 | 22.64 | | | | | | |
| 12.30 | 61.3 | 34.32 | 22.12 | 61.4 | 34.32 | 22.17 | 61.5 | 34.32 | 22.22 | 61.7 | 34.32 | 22.27 | 61.8 | 34.32 | 22.32 | 62.0 | 34.32 | 22.37 | 62.1 | 34.32 | 22.43 | 62.3 | 34.32 | 22.48 | 62.4 | 34.32 | 22.53 | 62.6 | 34.32 | 22.58 | | | | | | |
| 12.30 | 61.3 | 34.32 | 22.12 | 61.4 | 34.32 | 22.17 | 61.5 | 34.32 | 22.22 | 61.7 | 34.32 | 22.27 | 61.8 | 34.32 | 22.32 | 62.0 | 34.32 | 22.37 | 62.1 | 34.32 | 22.43 | 62.3 | 34.32 | 22.48 | 62.4 | 34.32 | 22.53 | 62.6 | 34.32 | 22.58 | | | | | | |
| 12.40 | 61.3 | 34.36 | 22.08 | 61.4 | 34.36 | 22.14 | 61.6 | 34.36 | 22.19 | 61.7 | 34.36 | 22.24 | 61.9 | 34.36 | 22.29 | 62.0 | 34.36 | 22.34 | 62.2 | 34.36 | 22.39 | 62.3 | 34.36 | 22.44 | 62.4 | 34.36 | 22.50 | 62.6 | 34.36 | 22.55 | | | | | | |
| 12.50 | 61.3 | 34.40 | 22.05 | 61.4 | 34.40 | 22.10 | 61.6 | 34.40 | 22.16 | 61.7 | 34.40 | 22.21 | 61.9 | 34.40 | 22.26 | 62.0 | 34.40 | 22.31 | 62.2 | 34.40 | 22.36 | 62.3 | 34.40 | 22.41 | 62.5 | 34.40 | 22.46 | 62.6 | 34.40 | 22.52 | | | | | | |
| 12.60 | 61.3 | 34.44 | 22.02 | 61.5 | 34.44 | 22.07 | 61.6 | 34.44 | 22.12 | 61.8 | 34.44 | 22.17 | 61.9 | 34.44 | 22.23 | 62.0 | 34.44 | 22.28 | 62.2 | 34.44 | 22.33 | 62.3 | 34.44 | 22.38 | 62.5 | 34.44 | 22.43 | 62.6 | 34.44 | 22.48 | | | | | | |
| 12.70 | 61.3 | 34.48 | 21.99 | 61.5 | 34.48 | 22.04 | 61.6 | 34.48 | 22.09 | 61.8 | 34.48 | 22.14 | 61.9 | 34.48 | 22.19 | 62.1 | 34.48 | 22.25 | 62.2 | 34.48 | 22.30 | 62.4 | 34.48 | 22.35 | 62.5 | 34.48 | 22.40 | 62.7 | 34.48 | 22.45 | | | | | | |
| 12.80 | 61.4 | 34.52 | 21.95 | 61.5 | 34.52 | 22.01 | 61.6 | 34.52 | 22.06 | 61.8 | 34.52 | 22.11 | 61.9 | 34.52 | 22.16 | 62.1 | 34.52 | 22.21 | 62.2 | 34.52 | 22.27 | 62.4 | 34.52 | 22.32 | 62.5 | 34.52 | 22.37 | 62.7 | 34.52 | 22.42 | | | | | | |
| 12.90 | 61.4 | 34.56 | 21.92 | 61.5 | 34.56 | 21.97 | 61.7 | 34.56 | 22.03 | 61.8 | 34.56 | 22.08 | 62.0 | 34.56 | 22.13 | 62.1 | 34.56 | 22.18 | 62.3 | 34.56 | 22.23 | 62.4 | 34.56 | 22.29 | 62.6 | 34.56 | 22.34 | 62.7 | 34.56 | 22.39 | | | | | | |
| 13.00 | 61.4 | 34.60 | 21.89 | 61.5 | 34.60 | 21.94 | 61.7 | 34.60 | 21.99 | 61.8 | 34.60 | 22.05 | 62.0 | 34.60 | 22.10 | 62.1 | 34.60 | 22.15 | 62.3 | 34.60 | 22.20 | 62.4 | 34.60 | 22.25 | 62.6 | 34.60 | 22.31 | 62.7 | 34.60 | 22.36 | | | | | | |
| 13.10 | 61.4 | 34.64 | 21.86 | 61.6 | 34.64 | 21.91 | 61.7 | 34.64 | 21.96 | 61.9 | 34.64 | 22.01 | 62.0 | 34.64 | 22.07 | 62.2 | 34.64 | 22.12 | 62.3 | 34.64 | 22.17 | 62.5 | 34.64 | 22.22 | 62.6 | 34.64 | 22.27 | 62.7 | 34.64 | 22.32 | | | | | | |
| 13.20 | 61.4 | 34.68 | 21.82 | 61.6 | 34.68 | 21.88 | 61.7 | 34.68 | 21.93 | 61.9 | 34.68 | 21.98 | 62.0 | 34.68 | 22.03 | 62.2 | 34.68 | 22.08 | 62.3 | 34.68 | 22.14 | 62.5 | 34.68 | 22.19 | 62.6 | 34.68 | 22.24 | 62.8 | 34.68 | 22.29 | | | | | | |
| 13.30 | 61.5 | 34.72 | 21.79 | 61.6 | 34.72 | 21.84 | 61.8 | 34.72 | 21.90 | 61.9 | 34.72 | 21.95 | 62.0 | 34.72 | 22.00 | 62.2 | 34.72 | 22.05 | 62.3 | 34.72 | 22.10 | 62.5 | 34.72 | 22.16 | 62.6 | 34.72 | 22.21 | 62.8 | 34.72 | 22.26 | | | | | | |
| 13.40 | 61.5 | 34.76 | 21.76 | 61.6 | 34.76 | 21.81 | 61.8 | 34.76 | 21.86 | 61.9 | 34.76 | 21.92 | 62.1 | 34.76 | 21.97 | 62.2 | 34.76 | 22.02 | 62.4 | 34.76 | 22.07 | 62.5 | 34.76 | 22.12 | 62.7 | 34.76 | 22.18 | 62.8 | 34.76 | 22.23 | | | | | | |
| 13.50 | 61.5 | 34.80 | 21.73 | 61.6 | 34.80 | 21.78 | 61.8 | 34.80 | 21.83 | 61.9 | 34.80 | 21.88 | 62.1 | 34.80 | 21.93 | 62.2 | 34.80 | 21.99 | 62.4 | 34.80 | 22.04 | 62.5 | 34.80 | 22.09 | 62.7 | 34.80 | 22.14 | 62.8 | 34.80 | 22.20 | | | | | | |
| 13.60 | 61.5 | 34.84 | 21.69 | 61.7 | 34.84 | 21.75 | 61.8 | 34.84 | 21.80 | 62.0 | 34.84 | 21.85 | 62.1 | 34.84 | 21.90 | 62.3 | 34.84 | 21.95 | 62.4 | 34.84 | 22.01 | 62.6 | 34.84 | 22.06 | 62.7 | 34.84 | 22.11 | 62.9 | 34.84 | 22.16 | | | | | | |
| 13.70 | 61.5 | 34.88 | 21.66 | 61.7 | 34.88 | 21.71 | 61.8 | 34.88 | 21.76 | 62.0 | 34.88 | 21.82 | 62.1 | 34.88 | 21.87 | 62.3 | 34.88 | 21.92 | 62.4 | 34.88 | 21.97 | 62.6 | 34.88 | 22.03 | 62.7 | 34.88 | 22.08 | 62.9 | 34.88 | 22.13 | | | | | | |
| 13.80 | 61.6 | 34.92 | 21.63 | 61.7 | 34.92 | 21.68 | 61.9 | 34.92 | 21.73 | 62.0 | 34.92 | 21.78 | 62.2 | 34.92 | 21.84 | 62.3 | 34.92 | 21.89 | 62.5 | 34.92 | 21.94 | 62.6 | 34.92 | 21.99 | 62.8 | 34.92 | 22.05 | 62.9 | 34.92 | 22.10 | | | | | | |
| 13.90 | 61.6 | 34.96 | 21.59 | 61.7 | 34.96 | 21.65 | 61.9 | 34.96 | 21.70 | 62.0 | 34.96 | 21.75 | 62.2 | 34.96 | 21.80 | 62.3 | 34.96 | 21.86 | 62.5 | 34.96 | 21.91 | 62.6 | 34.96 | 21.96 | 62.8 | 34.96 | 22.01 | 62.9 | 34.96 | 22.07 | | | | | | |
| 14.00 | 61.6 | 35.00 | 21.56 | 61.8 | 35.00 | 21.61 | 61.9 | 35.00 | 21.67 | 62.1 | 35.00 | 21.72 | 62.2 | 35.00 | 21.77 | 62.4 | 35.00 | 21.82 | 62.5 | 35.00 | 21.88 | 62.7 | 35.00 | 21.93 | 62.8 | 35.00 | 21.98 | 63.0 | 35.00 | 22.03 | | | | | | |
| 14.10 | 61.6 | 35.04 | 21.53 | 61.8 | 35.04 | 21.58 | 61.9 | 35.04 | 21.63 | 62.1 | 35.04 | 21.68 | 62.2 | 35.04 | 21.74 | 62.4 | 35.04 | 21.79 | 62.5 | 35.04 | 21.84 | 62.7 | 35.04 | 21.89 | 62.8 | 35.04 | 21.95 | 63.0 | 35.04 | 22.00 | | | | | | |
| 14.20 | 61.6 | 35.08 | 21.49 | 61.8 | 35.08 | 21.55 | 61.9 | 35.08 | 21.60 | 62.1 | 35.08 | 21.65 | 62.2 | 35.08 | 21.70 | 62.4 | 35.08 | 21.76 | 62.5 | 35.08 | 21.81 | 62.7 | 35.08 | 21.86 | 62.8 | 35.08 | 21.91 | 63.0 | 35.08 | 21.97 | | | | | | |
| 14.30 | 61.7 | 35.12 | 21.46 | 61.8 | 35.12 | 21.51 | 62.0 | 35.12 | 21.56 | 62.1 | 35.12 | 21.62 | 62.3 | 35.12 | 21.67 | 62.4 | 35.12 | 21.72 | 62.6 | 35.12 | 21.78 | 62.7 | 35.12 | 21.83 | 62.9 | 35.12 | 21.88 | 63.0 | 35.12 | 21.93 | | | | | | |
| 14.40 | 61.7 | 35.16 | 21.43 | 61.8 | 35.16 | 21.48 | 62.0 | 35.16 | 21.53 | 62.1 | 35.16 | 21.58 | 62.3 | 35.16 | 21.64 | 62.4 | 35.16 | 21.69 | 62.6 | 35.16 | 21.74 | 62.7 | 35.16 | 21.80 | 62.9 | 35.16 | 21.85 | 63.0 | 35.16 | 21.90 | | | | | | |
| 14.50 | 61.7 | 35.20 | 21.39 | 61.9 | 35.20 | 21.44 | 62.0 | 35.20 | 21.50 | 62.2 | 35.20 | 21.55 | 62.3 | 35.20 | 21.60 | 62.5 | 35.20 | 21.66 | 62.6 | 35.20 | 21.71 | 62.8 | 35.20 | 21.76 | 62.9 | 35.20 | 21.81 | 63.1 | 35.20 | 21.87 | | | | | | |
| 14.60 | 61.7 | 35.25 | 21.36 | 61.9 | 35.25 | 21.41 | 62.0 | 35.25 | 21.46 | 62.2 | 35.25 | 21.52 | 62.3 | 35.25 | 21.57 | 62.5 | 35.25 | 21.62 | 62.6 | 35.25 | 21.68 | 62.8 | 35.25 | 21.73 | 62.9 | 35.25 | 21.78 | 63.1 | 35.25 | 21.83 | | | | | | |
| 14.70 | 61.7 | 35.29 | 21.32 | 61.9 | 35.29 | 21.38 | 62.1 | 35.29 | 21.43 | 62.2 | 35.29 | 21.48 | 62.4 | 35.29 | 21.54 | 62.5 | 35.29 | 21.59 | 62.7 | 35.29 | 21.64 | 62.8 | 35.29 | 21.69 | 63.0 | 35.29 | 21.75 | 63.1 | 35.29 | 21.80 | | | | | | |
| 14.80 | 61.8 | 35.33 | 21.29 | 61.9 | 35.33 | 21.34 | 62.1 | 35.33 | 21.40 | 62.2 | 35.33 | 21.45 | 62.4 | 35.33 | 21.50 | 62.5 | 35.33 | 21.56 | 62.7 | 35.33 | 21.61 | 62.8 | 35.33 | 21.66 | 63.0 | 35.33 | 21.71 | 63.1 | 35.33 | 21.77 | | | | | | |
| 14.90 | 61.8 | 35.37 | 21.26 | 61.9 | 35.37 | 21.31 | 62.1 | 35.37 | 21.36 | 62.2 | 35.37 | 21.42 | 62.4 | 35.37 | 21.47 | 62.5 | 35.37 | 21.52 | 62.7 | 35.37 | 21.57 | 62.9 | 35.37 | 21.63 | 63.0 | 35.37 | 21.68 | 63.2 | 35.37 | 21.73 | | | | | | |
| 15.00 | 61.8 | 35.41 | 21.22 | 62.0 | 35.41 | 21.28 | 62.1 | 35.41 | 21.33 | 62.3 | 35.41 | 21.38 | 62.4 | 35.41 | 21.43 | 62.6 | 35.41 | 21.49 | 62.7 | 35.41 | 21.54 | 62.9 | 35.41 | 21.59 | 63.0 | 35.41 | 21.65 | 63.2 | 35.41 | 21.70 | | | | | | |
| 15.10 | 61.8 | 35.45 | 21.19 | 62.0 | 35.45 | 21.24 | 62.1 | 35.45 | 21.29 | 62.3 | 35.45 | 21.35 | 62.4 | 35.45 | 21.40 | 62.6 | 35.45 | 21.45 | 62.7 | 35.45 | 21.51 | 62.9 | 35.45 | 21.56 | 63.0 | 35.45 | 21.61 | 63.2 | 35.45 | 21.67 | | | | | | |
| 15.20 | 61.9 | 35.50 | 21.15 | 62.0 | 35.50 | 21.21 | 62.2 | 35.50 | 21.26 | 62.3 | 35.50 | 21.31 | 62.5 | 35.50 | 21.37 | 62.6 | 35.50 | 21.42 | 62.8 | 35.50 | 21.47 | 62.9 | 35.50 | 21.53 | 63.1 | 35.50 | 21.58 | 63.2 | 35.50 | 21.63 | | | | | | |
| 15.30 | 61.9 | 35.54 | 21.12 | 62.0 | 35.54 | 21.17 | 62.2 | 35.54 | 21.23 | 62.3 | 35.54 | 21.28 | 62.5 | 35.54 | 21.33 | 62.6 | 35.54 | 21.39 | 62.8 | 35.54 | 21.44 | 62.9 | 35.54 | 21.49 | 63.1 | 35.54 | 21.55 | 63.2 | 35.54 | 21.60 | | | | | | |
| 15.40 | 61.9 | 35.58 | 21.09 | 62.1 | 35.58 | 21.14 | 62.2 | 35.58 | 21.19 | 62.4 | 35.58 | 21.25 | 62.5 | 35.58 | 21.30 | 62.7 | 35.58 | 21.35 | 62.8 | 35.58 | 21.41 | 63.0 | 35.58 | 21.46 | 63.1 | 35.58 | 21.51 | 63.3 | 35.58 | 21.57 | | | | | | |
| 15.50 | 61.9 | 35.62 | 21.05 | 62.1 | 35.62 | 21.10 | 62.2 | 35.62 | 21.16 | 62.4 | 35.62 | 21.21 | 62.5 | 35.62 | 21.26 | 62.7 | 35.62 | 21.32 | 62.8 | 35.62 | 21.37 | 63.0 | 35.62 | 21.42 | 63.1 | 35.62 | 21.48 | 63.3 | 35.62 | 21.53 | | | | | | |
| 15.60 | 61.9 | 35.66 | 21.02 | 62.1 | 35.66 | 21.07 | 62.2 | 35.66 | 21.12 | 62.4 | 35.66 | 21.18 | 62.6 | 35.66 | 21.23 | 62.7 | 35.66 | 21.28 | 62.9 | 35.66 | 21.34 | 63.0 | 35.66 | 21.39 | 63.2 | 35.66 | 21.44 | 63.3 | 35.66 | 21.50 | | | | | | |
| 15.70 | 62.0 | 35.71 | 20.98 | 62.1 | 35.71 | 21.03 | 62.3 | 35.71 | 21.09 | 62.4 | 35.71 | 21.14 | 62.6 | 35.71 | 21.20 | 62.7 | 35.71 | 21.25 | 62.9 | 35.71 | 21.30 | 63.0 | 35.71 | 21.36 | 63.2 | 35.71 | 21.41 | 63.3 | 35.71 | 21.46 | | | | | | |
| 15.80 | 62.0 | 35.75 | 20.95 | 62.1 | 35.75 | 21.00 | 62.3 | 35.75 | 21.05 | 62.4 | 35.75 | 21.11 | 62.6 | 35.75 | 21.16 | 62.8 | 35.75 | 21.21 | 62.9 | 35.75 | 21.27 | 63.1 | 35.75 | 21.32 | 63.2 | 35.75 | 21.38 | 63.4 | 35.75 | 21.43 | | | | | | |
| 15.90 | 62.0 | 35.79 | 20.91 | 62.2 | 35.79 | 20.97 | 62.3 | 35.79 | 21.02 | 62.5 | 35.79 | 21.07 | 62.6 | 35.79 | 21.13 | 62.8 | 35.79 | 21.18 | 62.9 | 35.79 | 21.23 | 63.1 | 35.79 | 21.29 | 63.2 | 35.79 | 21.34 | 63.4 | 35.79 | 21.39 | | | | | | |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 35.0; Water (ml) = (% Absorption x 35.0 / 100) + (35.0 - sample weight)

## 35-gram Mixograph: Absorption, Flour and Water Amount Table
## (13.0 - 13.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 13.00 | | | 13.10 | | | 13.20 | | | 13.30 | | | 13.40 | | | 13.50 | | | 13.60 | | | 13.70 | | | 13.80 | | | 13.90 | | | | | | | | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | | | | | | |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | | | | | | |
| 9.00 | 62.0 | 33.08 | 23.63 | 62.2 | 33.08 | 23.68 | 62.3 | 33.08 | 23.73 | 62.5 | 33.08 | 23.78 | 62.6 | 33.08 | 23.83 | 62.7 | 33.08 | 23.88 | 62.9 | 33.08 | 23.93 | 63.0 | 33.08 | 23.98 | 63.2 | 33.08 | 24.03 | 63.3 | 33.08 | 24.08 | | | | | | |
| 9.10 | 62.0 | 33.11 | 23.60 | 62.2 | 33.11 | 23.65 | 62.3 | 33.11 | 23.70 | 62.5 | 33.11 | 23.75 | 62.6 | 33.11 | 23.80 | 62.8 | 33.11 | 23.85 | 62.9 | 33.11 | 23.90 | 63.0 | 33.11 | 23.95 | 63.2 | 33.11 | 24.00 | 63.3 | 33.11 | 24.05 | | | | | | |
| 9.20 | 62.1 | 33.15 | 23.57 | 62.2 | 33.15 | 23.62 | 62.4 | 33.15 | 23.67 | 62.5 | 33.15 | 23.72 | 62.6 | 33.15 | 23.77 | 62.8 | 33.15 | 23.82 | 62.9 | 33.15 | 23.87 | 63.1 | 33.15 | 23.92 | 63.2 | 33.15 | 23.97 | 63.3 | 33.15 | 24.02 | | | | | | |
| 9.30 | 62.1 | 33.19 | 23.55 | 62.2 | 33.19 | 23.59 | 62.4 | 33.19 | 23.64 | 62.5 | 33.19 | 23.69 | 62.7 | 33.19 | 23.74 | 62.8 | 33.19 | 23.79 | 62.9 | 33.19 | 23.84 | 63.1 | 33.19 | 23.89 | 63.2 | 33.19 | 23.94 | 63.4 | 33.19 | 23.99 | | | | | | |
| 9.40 | 62.1 | 33.22 | 23.52 | 62.3 | 33.22 | 23.57 | 62.4 | 33.22 | 23.62 | 62.5 | 33.22 | 23.67 | 62.7 | 33.22 | 23.71 | 62.8 | 33.22 | 23.76 | 63.0 | 33.22 | 23.81 | 63.1 | 33.22 | 23.86 | 63.2 | 33.22 | 23.91 | 63.4 | 33.22 | 23.96 | | | | | | |
| 9.50 | 62.1 | 33.26 | 23.49 | 62.3 | 33.26 | 23.54 | 62.4 | 33.26 | 23.59 | 62.6 | 33.26 | 23.64 | 62.7 | 33.26 | 23.69 | 62.8 | 33.26 | 23.74 | 63.0 | 33.26 | 23.79 | 63.1 | 33.26 | 23.84 | 63.3 | 33.26 | 23.89 | 63.4 | 33.26 | 23.93 | | | | | | |
| 9.60 | 62.2 | 33.30 | 23.46 | 62.3 | 33.30 | 23.51 | 62.4 | 33.30 | 23.56 | 62.6 | 33.30 | 23.61 | 62.7 | 33.30 | 23.66 | 62.9 | 33.30 | 23.71 | 63.0 | 33.30 | 23.76 | 63.1 | 33.30 | 23.81 | 63.3 | 33.30 | 23.86 | 63.4 | 33.30 | 23.91 | | | | | | |
| 9.70 | 62.2 | 33.33 | 23.43 | 62.3 | 33.33 | 23.48 | 62.5 | 33.33 | 23.53 | 62.6 | 33.33 | 23.58 | 62.7 | 33.33 | 23.63 | 62.9 | 33.33 | 23.68 | 63.0 | 33.33 | 23.73 | 63.2 | 33.33 | 23.78 | 63.3 | 33.33 | 23.83 | 63.5 | 33.33 | 23.88 | | | | | | |
| 9.80 | 62.2 | 33.37 | 23.40 | 62.3 | 33.37 | 23.45 | 62.5 | 33.37 | 23.50 | 62.6 | 33.37 | 23.55 | 62.8 | 33.37 | 23.60 | 62.9 | 33.37 | 23.65 | 63.1 | 33.37 | 23.70 | 63.2 | 33.37 | 23.75 | 63.3 | 33.37 | 23.80 | 63.5 | 33.37 | 23.85 | | | | | | |
| 9.90 | 62.2 | 33.41 | 23.37 | 62.4 | 33.41 | 23.42 | 62.5 | 33.41 | 23.47 | 62.6 | 33.41 | 23.52 | 62.8 | 33.41 | 23.57 | 62.9 | 33.41 | 23.62 | 63.1 | 33.41 | 23.67 | 63.2 | 33.41 | 23.72 | 63.4 | 33.41 | 23.77 | 63.5 | 33.41 | 23.82 | | | | | | |
| 10.00 | 62.2 | 33.44 | 23.34 | 62.4 | 33.44 | 23.39 | 62.5 | 33.44 | 23.44 | 62.7 | 33.44 | 23.49 | 62.8 | 33.44 | 23.54 | 63.0 | 33.44 | 23.59 | 63.1 | 33.44 | 23.64 | 63.2 | 33.44 | 23.69 | 63.4 | 33.44 | 23.74 | 63.5 | 33.44 | 23.79 | | | | | | |
| 10.10 | 62.3 | 33.48 | 23.31 | 62.4 | 33.48 | 23.36 | 62.5 | 33.48 | 23.41 | 62.7 | 33.48 | 23.46 | 62.8 | 33.48 | 23.51 | 63.0 | 33.48 | 23.56 | 63.1 | 33.48 | 23.61 | 63.3 | 33.48 | 23.66 | 63.4 | 33.48 | 23.71 | 63.5 | 33.48 | 23.76 | | | | | | |
| 10.20 | 62.3 | 33.52 | 23.28 | 62.4 | 33.52 | 23.33 | 62.6 | 33.52 | 23.38 | 62.7 | 33.52 | 23.43 | 62.8 | 33.52 | 23.48 | 63.0 | 33.52 | 23.53 | 63.1 | 33.52 | 23.58 | 63.3 | 33.52 | 23.63 | 63.4 | 33.52 | 23.68 | 63.6 | 33.52 | 23.73 | | | | | | |
| 10.30 | 62.3 | 33.56 | 23.25 | 62.4 | 33.56 | 23.30 | 62.6 | 33.56 | 23.35 | 62.7 | 33.56 | 23.40 | 62.9 | 33.56 | 23.45 | 63.0 | 33.56 | 23.50 | 63.2 | 33.56 | 23.55 | 63.3 | 33.56 | 23.60 | 63.4 | 33.56 | 23.65 | 63.6 | 33.56 | 23.70 | | | | | | |
| 10.40 | 62.3 | 33.59 | 23.22 | 62.5 | 33.59 | 23.27 | 62.6 | 33.59 | 23.32 | 62.7 | 33.59 | 23.37 | 62.9 | 33.59 | 23.42 | 63.0 | 33.59 | 23.47 | 63.2 | 33.59 | 23.52 | 63.3 | 33.59 | 23.57 | 63.5 | 33.59 | 23.62 | 63.6 | 33.59 | 23.67 | | | | | | |
| 10.50 | 62.3 | 33.63 | 23.19 | 62.5 | 33.63 | 23.24 | 62.6 | 33.63 | 23.29 | 62.8 | 33.63 | 23.34 | 62.9 | 33.63 | 23.39 | 63.1 | 33.63 | 23.44 | 63.2 | 33.63 | 23.49 | 63.3 | 33.63 | 23.54 | 63.5 | 33.63 | 23.59 | 63.6 | 33.63 | 23.64 | | | | | | |
| 10.60 | 62.4 | 33.67 | 23.16 | 62.5 | 33.67 | 23.21 | 62.6 | 33.67 | 23.26 | 62.8 | 33.67 | 23.31 | 62.9 | 33.67 | 23.36 | 63.1 | 33.67 | 23.41 | 63.2 | 33.67 | 23.46 | 63.4 | 33.67 | 23.51 | 63.5 | 33.67 | 23.56 | 63.7 | 33.67 | 23.61 | | | | | | |
| 10.70 | 62.4 | 33.71 | 23.13 | 62.5 | 33.71 | 23.18 | 62.7 | 33.71 | 23.23 | 62.8 | 33.71 | 23.28 | 63.0 | 33.71 | 23.33 | 63.1 | 33.71 | 23.38 | 63.2 | 33.71 | 23.43 | 63.4 | 33.71 | 23.48 | 63.5 | 33.71 | 23.53 | 63.7 | 33.71 | 23.58 | | | | | | |
| 10.80 | 62.4 | 33.74 | 23.10 | 62.5 | 33.74 | 23.15 | 62.7 | 33.74 | 23.20 | 62.8 | 33.74 | 23.25 | 63.0 | 33.74 | 23.30 | 63.1 | 33.74 | 23.35 | 63.3 | 33.74 | 23.40 | 63.4 | 33.74 | 23.45 | 63.6 | 33.74 | 23.50 | 63.7 | 33.74 | 23.55 | | | | | | |
| 10.90 | 62.4 | 33.78 | 23.07 | 62.6 | 33.78 | 23.12 | 62.7 | 33.78 | 23.17 | 62.9 | 33.78 | 23.22 | 63.0 | 33.78 | 23.27 | 63.1 | 33.78 | 23.32 | 63.3 | 33.78 | 23.37 | 63.4 | 33.78 | 23.42 | 63.6 | 33.78 | 23.47 | 63.7 | 33.78 | 23.52 | | | | | | |
| 11.00 | 62.4 | 33.82 | 23.03 | 62.6 | 33.82 | 23.09 | 62.7 | 33.82 | 23.14 | 62.9 | 33.82 | 23.19 | 63.0 | 33.82 | 23.24 | 63.2 | 33.82 | 23.29 | 63.3 | 33.82 | 23.34 | 63.5 | 33.82 | 23.39 | 63.6 | 33.82 | 23.44 | 63.7 | 33.82 | 23.49 | | | | | | |
| 11.10 | 62.5 | 33.86 | 23.00 | 62.6 | 33.86 | 23.05 | 62.8 | 33.86 | 23.11 | 62.9 | 33.86 | 23.16 | 63.0 | 33.86 | 23.21 | 63.2 | 33.86 | 23.26 | 63.3 | 33.86 | 23.31 | 63.5 | 33.86 | 23.36 | 63.6 | 33.86 | 23.41 | 63.8 | 33.86 | 23.46 | | | | | | |
| 11.20 | 62.5 | 33.90 | 22.97 | 62.6 | 33.90 | 23.02 | 62.8 | 33.90 | 23.08 | 62.9 | 33.90 | 23.13 | 63.1 | 33.90 | 23.18 | 63.2 | 33.90 | 23.23 | 63.4 | 33.90 | 23.28 | 63.5 | 33.90 | 23.33 | 63.6 | 33.90 | 23.38 | 63.8 | 33.90 | 23.43 | | | | | | |
| 11.30 | 62.5 | 33.93 | 22.94 | 62.7 | 33.93 | 22.99 | 62.8 | 33.93 | 23.04 | 62.9 | 33.93 | 23.10 | 63.1 | 33.93 | 23.15 | 63.2 | 33.93 | 23.20 | 63.4 | 33.93 | 23.25 | 63.5 | 33.93 | 23.30 | 63.7 | 33.93 | 23.35 | 63.8 | 33.93 | 23.40 | | | | | | |
| 11.40 | 62.5 | 33.97 | 22.91 | 62.7 | 33.97 | 22.96 | 62.8 | 33.97 | 23.01 | 63.0 | 33.97 | 23.06 | 63.1 | 33.97 | 23.12 | 63.3 | 33.97 | 23.17 | 63.4 | 33.97 | 23.22 | 63.5 | 33.97 | 23.27 | 63.7 | 33.97 | 23.32 | 63.8 | 33.97 | 23.37 | | | | | | |
| 11.50 | 62.5 | 34.01 | 22.88 | 62.7 | 34.01 | 22.93 | 62.8 | 34.01 | 22.98 | 63.0 | 34.01 | 23.03 | 63.1 | 34.01 | 23.08 | 63.3 | 34.01 | 23.14 | 63.4 | 34.01 | 23.19 | 63.6 | 34.01 | 23.24 | 63.7 | 34.01 | 23.29 | 63.9 | 34.01 | 23.34 | | | | | | |
| 11.60 | 62.6 | 34.05 | 22.85 | 62.7 | 34.05 | 22.90 | 62.9 | 34.05 | 22.95 | 63.0 | 34.05 | 23.00 | 63.2 | 34.05 | 23.05 | 63.3 | 34.05 | 23.11 | 63.4 | 34.05 | 23.16 | 63.6 | 34.05 | 23.21 | 63.7 | 34.05 | 23.26 | 63.9 | 34.05 | 23.31 | | | | | | |
| 11.70 | 62.6 | 34.09 | 22.82 | 62.7 | 34.09 | 22.87 | 62.9 | 34.09 | 22.92 | 63.0 | 34.09 | 22.97 | 63.2 | 34.09 | 23.02 | 63.3 | 34.09 | 23.07 | 63.5 | 34.09 | 23.13 | 63.6 | 34.09 | 23.18 | 63.8 | 34.09 | 23.23 | 63.9 | 34.09 | 23.28 | | | | | | |
| 11.80 | 62.6 | 34.13 | 22.79 | 62.8 | 34.13 | 22.84 | 62.9 | 34.13 | 22.89 | 63.1 | 34.13 | 22.94 | 63.2 | 34.13 | 22.99 | 63.3 | 34.13 | 23.04 | 63.5 | 34.13 | 23.09 | 63.6 | 34.13 | 23.15 | 63.8 | 34.13 | 23.20 | 63.9 | 34.13 | 23.25 | | | | | | |
| 11.90 | 62.6 | 34.17 | 22.76 | 62.8 | 34.17 | 22.81 | 62.9 | 34.17 | 22.86 | 63.1 | 34.17 | 22.91 | 63.2 | 34.17 | 22.96 | 63.4 | 34.17 | 23.01 | 63.5 | 34.17 | 23.06 | 63.7 | 34.17 | 23.12 | 63.8 | 34.17 | 23.17 | 64.0 | 34.17 | 23.22 | | | | | | |
| 12.00 | 62.7 | 34.20 | 22.73 | 62.8 | 34.20 | 22.78 | 63.0 | 34.20 | 22.83 | 63.1 | 34.20 | 22.88 | 63.2 | 34.20 | 22.93 | 63.4 | 34.20 | 22.98 | 63.5 | 34.20 | 23.03 | 63.7 | 34.20 | 23.08 | 63.8 | 34.20 | 23.14 | 64.0 | 34.20 | 23.19 | | | | | | |
| 12.10 | 62.7 | 34.24 | 22.69 | 62.8 | 34.24 | 22.75 | 63.0 | 34.24 | 22.80 | 63.1 | 34.24 | 22.85 | 63.3 | 34.24 | 22.90 | 63.4 | 34.24 | 22.95 | 63.6 | 34.24 | 23.00 | 63.7 | 34.24 | 23.05 | 63.9 | 34.24 | 23.10 | 64.0 | 34.24 | 23.16 | | | | | | |
| 12.30 | 62.7 | 34.32 | 22.63 | 62.9 | 34.32 | 22.68 | 63.0 | 34.32 | 22.73 | 63.2 | 34.32 | 22.79 | 63.3 | 34.32 | 22.84 | 63.5 | 34.32 | 22.89 | 63.6 | 34.32 | 22.94 | 63.8 | 34.32 | 22.99 | 63.9 | 34.32 | 23.04 | 64.0 | 34.32 | 23.09 | | | | | | |
| 12.30 | 62.7 | 34.32 | 22.63 | 62.9 | 34.32 | 22.68 | 63.0 | 34.32 | 22.73 | 63.2 | 34.32 | 22.79 | 63.3 | 34.32 | 22.84 | 63.5 | 34.32 | 22.89 | 63.6 | 34.32 | 22.94 | 63.8 | 34.32 | 22.99 | 63.9 | 34.32 | 23.04 | 64.0 | 34.32 | 23.09 | | | | | | |
| 12.40 | 62.7 | 34.36 | 22.60 | 62.9 | 34.36 | 22.65 | 63.0 | 34.36 | 22.70 | 63.2 | 34.36 | 22.75 | 63.3 | 34.36 | 22.81 | 63.5 | 34.36 | 22.86 | 63.6 | 34.36 | 22.91 | 63.8 | 34.36 | 22.96 | 63.9 | 34.36 | 23.01 | 64.1 | 34.36 | 23.06 | | | | | | |
| 12.50 | 62.8 | 34.40 | 22.57 | 62.9 | 34.40 | 22.62 | 63.1 | 34.40 | 22.67 | 63.2 | 34.40 | 22.72 | 63.4 | 34.40 | 22.77 | 63.5 | 34.40 | 22.83 | 63.7 | 34.40 | 22.88 | 63.8 | 34.40 | 22.93 | 63.9 | 34.40 | 22.98 | 64.1 | 34.40 | 23.03 | | | | | | |
| 12.60 | 62.8 | 34.44 | 22.54 | 62.9 | 34.44 | 22.59 | 63.1 | 34.44 | 22.64 | 63.2 | 34.44 | 22.69 | 63.4 | 34.44 | 22.74 | 63.5 | 34.44 | 22.79 | 63.7 | 34.44 | 22.85 | 63.8 | 34.44 | 22.90 | 64.0 | 34.44 | 22.95 | 64.1 | 34.44 | 23.00 | | | | | | |
| 12.70 | 62.8 | 34.48 | 22.50 | 63.0 | 34.48 | 22.56 | 63.1 | 34.48 | 22.61 | 63.3 | 34.48 | 22.66 | 63.4 | 34.48 | 22.71 | 63.5 | 34.48 | 22.76 | 63.7 | 34.48 | 22.81 | 63.8 | 34.48 | 22.87 | 64.0 | 34.48 | 22.92 | 64.1 | 34.48 | 22.97 | | | | | | |
| 12.80 | 62.8 | 34.52 | 22.47 | 63.0 | 34.52 | 22.52 | 63.1 | 34.52 | 22.58 | 63.3 | 34.52 | 22.63 | 63.4 | 34.52 | 22.68 | 63.6 | 34.52 | 22.73 | 63.7 | 34.52 | 22.78 | 63.9 | 34.52 | 22.84 | 64.0 | 34.52 | 22.89 | 64.2 | 34.52 | 22.94 | | | | | | |
| 12.90 | 62.9 | 34.56 | 22.44 | 63.0 | 34.56 | 22.49 | 63.1 | 34.56 | 22.54 | 63.3 | 34.56 | 22.60 | 63.4 | 34.56 | 22.65 | 63.6 | 34.56 | 22.70 | 63.7 | 34.56 | 22.75 | 63.9 | 34.56 | 22.80 | 64.0 | 34.56 | 22.86 | 64.2 | 34.56 | 22.91 | | | | | | |
| 13.00 | 62.9 | 34.60 | 22.41 | 63.0 | 34.60 | 22.46 | 63.2 | 34.60 | 22.51 | 63.3 | 34.60 | 22.56 | 63.5 | 34.60 | 22.62 | 63.6 | 34.60 | 22.67 | 63.8 | 34.60 | 22.72 | 63.9 | 34.60 | 22.77 | 64.1 | 34.60 | 22.82 | 64.2 | 34.60 | 22.88 | | | | | | |
| 13.10 | 62.9 | 34.64 | 22.38 | 63.0 | 34.64 | 22.43 | 63.2 | 34.64 | 22.48 | 63.3 | 34.64 | 22.53 | 63.5 | 34.64 | 22.58 | 63.6 | 34.64 | 22.64 | 63.8 | 34.64 | 22.69 | 63.9 | 34.64 | 22.74 | 64.1 | 34.64 | 22.79 | 64.2 | 34.64 | 22.84 | | | | | | |
| 13.20 | 62.9 | 34.68 | 22.34 | 63.1 | 34.68 | 22.40 | 63.2 | 34.68 | 22.45 | 63.4 | 34.68 | 22.50 | 63.5 | 34.68 | 22.55 | 63.7 | 34.68 | 22.60 | 63.8 | 34.68 | 22.66 | 64.0 | 34.68 | 22.71 | 64.1 | 34.68 | 22.76 | 64.3 | 34.68 | 22.81 | | | | | | |
| 13.30 | 62.9 | 34.72 | 22.31 | 63.1 | 34.72 | 22.36 | 63.2 | 34.72 | 22.42 | 63.4 | 34.72 | 22.47 | 63.5 | 34.72 | 22.52 | 63.7 | 34.72 | 22.57 | 63.8 | 34.72 | 22.62 | 64.0 | 34.72 | 22.68 | 64.1 | 34.72 | 22.73 | 64.3 | 34.72 | 22.78 | | | | | | |
| 13.40 | 63.0 | 34.76 | 22.28 | 63.1 | 34.76 | 22.33 | 63.3 | 34.76 | 22.38 | 63.4 | 34.76 | 22.44 | 63.6 | 34.76 | 22.49 | 63.7 | 34.76 | 22.54 | 63.9 | 34.76 | 22.59 | 64.0 | 34.76 | 22.65 | 64.2 | 34.76 | 22.70 | 64.3 | 34.76 | 22.75 | | | | | | |
| 13.50 | 63.0 | 34.80 | 22.25 | 63.1 | 34.80 | 22.30 | 63.3 | 34.80 | 22.35 | 63.4 | 34.80 | 22.40 | 63.6 | 34.80 | 22.46 | 63.7 | 34.80 | 22.51 | 63.9 | 34.80 | 22.56 | 64.0 | 34.80 | 22.61 | 64.2 | 34.80 | 22.67 | 64.3 | 34.80 | 22.72 | | | | | | |
| 13.60 | 63.0 | 34.84 | 22.22 | 63.2 | 34.84 | 22.27 | 63.3 | 34.84 | 22.32 | 63.5 | 34.84 | 22.37 | 63.6 | 34.84 | 22.42 | 63.8 | 34.84 | 22.48 | 63.9 | 34.84 | 22.53 | 64.1 | 34.84 | 22.58 | 64.2 | 34.84 | 22.63 | 64.4 | 34.84 | 22.69 | | | | | | |
| 13.70 | 63.0 | 34.88 | 22.18 | 63.2 | 34.88 | 22.24 | 63.3 | 34.88 | 22.29 | 63.5 | 34.88 | 22.34 | 63.6 | 34.88 | 22.39 | 63.8 | 34.88 | 22.44 | 63.9 | 34.88 | 22.50 | 64.1 | 34.88 | 22.55 | 64.2 | 34.88 | 22.60 | 64.4 | 34.88 | 22.65 | | | | | | |
| 13.80 | 63.1 | 34.92 | 22.15 | 63.2 | 34.92 | 22.20 | 63.4 | 34.92 | 22.26 | 63.5 | 34.92 | 22.31 | 63.7 | 34.92 | 22.36 | 63.8 | 34.92 | 22.41 | 64.0 | 34.92 | 22.46 | 64.1 | 34.92 | 22.52 | 64.3 | 34.92 | 22.57 | 64.4 | 34.92 | 22.62 | | | | | | |
| 13.90 | 63.1 | 34.96 | 22.12 | 63.2 | 34.96 | 22.17 | 63.4 | 34.96 | 22.22 | 63.5 | 34.96 | 22.28 | 63.7 | 34.96 | 22.33 | 63.8 | 34.96 | 22.38 | 64.0 | 34.96 | 22.43 | 64.1 | 34.96 | 22.48 | 64.3 | 34.96 | 22.54 | 64.4 | 34.96 | 22.59 | | | | | | |
| 14.00 | 63.1 | 35.00 | 22.09 | 63.3 | 35.00 | 22.14 | 63.4 | 35.00 | 22.19 | 63.6 | 35.00 | 22.24 | 63.7 | 35.00 | 22.30 | 63.9 | 35.00 | 22.35 | 64.0 | 35.00 | 22.40 | 64.2 | 35.00 | 22.45 | 64.3 | 35.00 | 22.51 | 64.5 | 35.00 | 22.56 | | | | | | |
| 14.10 | 63.1 | 35.04 | 22.05 | 63.3 | 35.04 | 22.10 | 63.4 | 35.04 | 22.16 | 63.6 | 35.04 | 22.21 | 63.7 | 35.04 | 22.26 | 63.9 | 35.04 | 22.32 | 64.0 | 35.04 | 22.37 | 64.2 | 35.04 | 22.42 | 64.3 | 35.04 | 22.47 | 64.5 | 35.04 | 22.53 | | | | | | |
| 14.20 | 63.1 | 35.08 | 22.02 | 63.3 | 35.08 | 22.07 | 63.4 | 35.08 | 22.12 | 63.6 | 35.08 | 22.18 | 63.7 | 35.08 | 22.23 | 63.9 | 35.08 | 22.28 | 64.0 | 35.08 | 22.34 | 64.2 | 35.08 | 22.39 | 64.3 | 35.08 | 22.44 | 64.5 | 35.08 | 22.49 | | | | | | |
| 14.30 | 63.2 | 35.12 | 21.99 | 63.3 | 35.12 | 22.04 | 63.5 | 35.12 | 22.09 | 63.6 | 35.12 | 22.14 | 63.8 | 35.12 | 22.20 | 63.9 | 35.12 | 22.25 | 64.1 | 35.12 | 22.30 | 64.2 | 35.12 | 22.36 | 64.4 | 35.12 | 22.41 | 64.5 | 35.12 | 22.46 | | | | | | |
| 14.40 | 63.2 | 35.16 | 21.95 | 63.3 | 35.16 | 22.01 | 63.5 | 35.16 | 22.06 | 63.6 | 35.16 | 22.11 | 63.8 | 35.16 | 22.16 | 63.9 | 35.16 | 22.22 | 64.1 | 35.16 | 22.27 | 64.2 | 35.16 | 22.32 | 64.4 | 35.16 | 22.38 | 64.5 | 35.16 | 22.43 | | | | | | |
| 14.50 | 63.2 | 35.20 | 21.92 | 63.4 | 35.20 | 21.97 | 63.5 | 35.20 | 22.03 | 63.7 | 35.20 | 22.08 | 63.8 | 35.20 | 22.13 | 64.0 | 35.20 | 22.18 | 64.1 | 35.20 | 22.24 | 64.3 | 35.20 | 22.29 | 64.4 | 35.20 | 22.34 | 64.6 | 35.20 | 22.40 | | | | | | |
| 14.60 | 63.2 | 35.25 | 21.89 | 63.4 | 35.25 | 21.94 | 63.5 | 35.25 | 21.99 | 63.7 | 35.25 | 22.05 | 63.8 | 35.25 | 22.10 | 64.0 | 35.25 | 22.15 | 64.1 | 35.25 | 22.20 | 64.3 | 35.25 | 22.26 | 64.4 | 35.25 | 22.31 | 64.6 | 35.25 | 22.36 | | | | | | |
| 14.70 | 63.3 | 35.29 | 21.85 | 63.4 | 35.29 | 21.91 | 63.6 | 35.29 | 21.96 | 63.7 | 35.29 | 22.01 | 63.9 | 35.29 | 22.07 | 64.0 | 35.29 | 22.12 | 64.2 | 35.29 | 22.17 | 64.3 | 35.29 | 22.22 | 64.5 | 35.29 | 22.28 | 64.6 | 35.29 | 22.33 | | | | | | |
| 14.80 | 63.3 | 35.33 | 21.82 | 63.4 | 35.33 | 21.87 | 63.6 | 35.33 | 21.93 | 63.7 | 35.33 | 21.98 | 63.9 | 35.33 | 22.03 | 64.0 | 35.33 | 22.09 | 64.2 | 35.33 | 22.14 | 64.3 | 35.33 | 22.19 | 64.5 | 35.33 | 22.24 | 64.6 | 35.33 | 22.30 | | | | | | |
| 14.90 | 63.3 | 35.37 | 21.79 | 63.5 | 35.37 | 21.84 | 63.6 | 35.37 | 21.89 | 63.8 | 35.37 | 21.95 | 63.9 | 35.37 | 22.00 | 64.1 | 35.37 | 22.05 | 64.2 | 35.37 | 22.11 | 64.4 | 35.37 | 22.16 | 64.5 | 35.37 | 22.21 | 64.7 | 35.37 | 22.26 | | | | | | |
| 15.00 | 63.3 | 35.41 | 21.75 | 63.5 | 35.41 | 21.81 | 63.6 | 35.41 | 21.86 | 63.8 | 35.41 | 21.91 | 63.9 | 35.41 | 21.97 | 64.1 | 35.41 | 22.02 | 64.2 | 35.41 | 22.07 | 64.4 | 35.41 | 22.13 | 64.5 | 35.41 | 22.18 | 64.7 | 35.41 | 22.23 | | | | | | |
| 15.10 | 63.4 | 35.45 | 21.72 | 63.5 | 35.45 | 21.77 | 63.7 | 35.45 | 21.83 | 63.8 | 35.45 | 21.88 | 64.0 | 35.45 | 21.93 | 64.1 | 35.45 | 21.99 | 64.3 | 35.45 | 22.04 | 64.4 | 35.45 | 22.09 | 64.6 | 35.45 | 22.15 | 64.7 | 35.45 | 22.20 | | | | | | |
| 15.20 | 63.4 | 35.50 | 21.69 | 63.5 | 35.50 | 21.74 | 63.7 | 35.50 | 21.79 | 63.8 | 35.50 | 21.85 | 64.0 | 35.50 | 21.90 | 64.1 | 35.50 | 21.95 | 64.3 | 35.50 | 22.01 | 64.4 | 35.50 | 22.06 | 64.6 | 35.50 | 22.11 | 64.7 | 35.50 | 22.17 | | | | | | |
| 15.30 | 63.4 | 35.54 | 21.65 | 63.6 | 35.54 | 21.71 | 63.7 | 35.54 | 21.76 | 63.9 | 35.54 | 21.81 | 64.0 | 35.54 | 21.87 | 64.2 | 35.54 | 21.92 | 64.3 | 35.54 | 21.97 | 64.5 | 35.54 | 22.03 | 64.6 | 35.54 | 22.08 | 64.8 | 35.54 | 22.13 | | | | | | |
| 15.40 | 63.4 | 35.58 | 21.62 | 63.6 | 35.58 | 21.67 | 63.7 | 35.58 | 21.73 | 63.9 | 35.58 | 21.78 | 64.0 | 35.58 | 21.83 | 64.2 | 35.58 | 21.89 | 64.3 | 35.58 | 21.94 | 64.5 | 35.58 | 21.99 | 64.6 | 35.58 | 22.05 | 64.8 | 35.58 | 22.10 | | | | | | |
| 15.50 | 63.4 | 35.62 | 21.58 | 63.6 | 35.62 | 21.64 | 63.8 | 35.62 | 21.69 | 63.9 | 35.62 | 21.75 | 64.1 | 35.62 | 21.80 | 64.2 | 35.62 | 21.85 | 64.4 | 35.62 | 21.91 | 64.5 | 35.62 | 21.96 | 64.7 | 35.62 | 22.01 | 64.8 | 35.62 | 22.07 | | | | | | |
| 15.60 | 63.5 | 35.66 | 21.55 | 63.6 | 35.66 | 21.60 | 63.8 | 35.66 | 21.66 | 63.9 | 35.66 | 21.71 | 64.1 | 35.66 | 21.76 | 64.2 | 35.66 | 21.82 | 64.4 | 35.66 | 21.87 | 64.5 | 35.66 | 21.93 | 64.7 | 35.66 | 21.98 | 64.8 | 35.66 | 22.03 | | | | | | |
| 15.70 | 63.5 | 35.71 | 21.52 | 63.6 | 35.71 | 21.57 | 63.8 | 35.71 | 21.62 | 64.0 | 35.71 | 21.68 | 64.1 | 35.71 | 21.73 | 64.3 | 35.71 | 21.78 | 64.4 | 35.71 | 21.84 | 64.6 | 35.71 | 21.89 | 64.7 | 35.71 | 21.95 | 64.9 | 35.71 | 22.00 | | | | | | |
| 15.80 | 63.5 | 35.75 | 21.48 | 63.7 | 35.75 | 21.54 | 63.8 | 35.75 | 21.59 | 64.0 | 35.75 | 21.64 | 64.1 | 35.75 | 21.70 | 64.3 | 35.75 | 21.75 | 64.4 | 35.75 | 21.80 | 64.6 | 35.75 | 21.86 | 64.7 | 35.75 | 21.91 | 64.9 | 35.75 | 21.97 | | | | | | |
| 15.90 | 63.5 | 35.79 | 21.45 | 63.7 | 35.79 | 21.50 | 63.8 | 35.79 | 21.56 | 64.0 | 35.79 | 21.61 | 64.2 | 35.79 | 21.66 | 64.3 | 35.79 | 21.72 | 64.5 | 35.79 | 21.77 | 64.6 | 35.79 | 21.82 | 64.8 | 35.79 | 21.88 | 64.9 | 35.79 | 21.93 | | | | | | |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 35.0; Water (ml) = (% Absorption x 35.0 / 100) + (35.0 - sample weight)

## 35-gram Mixograph: Absorption, Flour and Water Amount Table
## (14.0 - 14.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 14.00 | | | 14.10 | | | 14.20 | | | 14.30 | | | 14.40 | | | 14.50 | | | 14.60 | | | 14.70 | | | 14.80 | | | 14.90 | | | | | | | | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | | | | | | |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | | | | | | |
| 9.00 | 63.4 | 33.08 | 24.13 | 63.6 | 33.08 | 24.18 | 63.7 | 33.08 | 24.23 | 63.9 | 33.08 | 24.28 | 64.0 | 33.08 | 24.33 | 64.2 | 33.08 | 24.38 | 64.3 | 33.08 | 24.43 | 64.4 | 33.08 | 24.48 | 64.6 | 33.08 | 24.53 | 64.7 | 33.08 | 24.58 | | | | | | |
| 9.10 | 63.5 | 33.11 | 24.10 | 63.6 | 33.11 | 24.15 | 63.8 | 33.11 | 24.20 | 63.9 | 33.11 | 24.25 | 64.0 | 33.11 | 24.30 | 64.2 | 33.11 | 24.35 | 64.3 | 33.11 | 24.40 | 64.5 | 33.11 | 24.45 | 64.6 | 33.11 | 24.50 | 64.7 | 33.11 | 24.55 | | | | | | |
| 9.20 | 63.5 | 33.15 | 24.07 | 63.6 | 33.15 | 24.12 | 63.8 | 33.15 | 24.17 | 63.9 | 33.15 | 24.22 | 64.1 | 33.15 | 24.27 | 64.2 | 33.15 | 24.32 | 64.3 | 33.15 | 24.37 | 64.5 | 33.15 | 24.42 | 64.6 | 33.15 | 24.47 | 64.8 | 33.15 | 24.52 | | | | | | |
| 9.30 | 63.5 | 33.19 | 24.04 | 63.7 | 33.19 | 24.09 | 63.8 | 33.19 | 24.14 | 63.9 | 33.19 | 24.19 | 64.1 | 33.19 | 24.24 | 64.2 | 33.19 | 24.29 | 64.4 | 33.19 | 24.34 | 64.5 | 33.19 | 24.39 | 64.6 | 33.19 | 24.44 | 64.8 | 33.19 | 24.49 | | | | | | |
| 9.40 | 63.5 | 33.22 | 24.01 | 63.7 | 33.22 | 24.06 | 63.8 | 33.22 | 24.11 | 64.0 | 33.22 | 24.16 | 64.1 | 33.22 | 24.21 | 64.2 | 33.22 | 24.26 | 64.4 | 33.22 | 24.31 | 64.5 | 33.22 | 24.36 | 64.7 | 33.22 | 24.41 | 64.8 | 33.22 | 24.46 | | | | | | |
| 9.50 | 63.6 | 33.26 | 23.98 | 63.7 | 33.26 | 24.03 | 63.8 | 33.26 | 24.08 | 64.0 | 33.26 | 24.13 | 64.1 | 33.26 | 24.18 | 64.3 | 33.26 | 24.23 | 64.4 | 33.26 | 24.28 | 64.6 | 33.26 | 24.33 | 64.7 | 33.26 | 24.38 | 64.8 | 33.26 | 24.43 | | | | | | |
| 9.60 | 63.6 | 33.30 | 23.96 | 63.7 | 33.30 | 24.01 | 63.9 | 33.30 | 24.06 | 64.0 | 33.30 | 24.11 | 64.1 | 33.30 | 24.16 | 64.3 | 33.30 | 24.21 | 64.4 | 33.30 | 24.26 | 64.6 | 33.30 | 24.31 | 64.7 | 33.30 | 24.36 | 64.9 | 33.30 | 24.41 | | | | | | |
| 9.70 | 63.6 | 33.33 | 23.93 | 63.7 | 33.33 | 23.98 | 63.9 | 33.33 | 24.03 | 64.0 | 33.33 | 24.08 | 64.2 | 33.33 | 24.13 | 64.3 | 33.33 | 24.18 | 64.5 | 33.33 | 24.23 | 64.6 | 33.33 | 24.28 | 64.7 | 33.33 | 24.33 | 64.9 | 33.33 | 24.38 | | | | | | |
| 9.80 | 63.6 | 33.37 | 23.90 | 63.8 | 33.37 | 23.95 | 63.9 | 33.37 | 24.00 | 64.1 | 33.37 | 24.05 | 64.2 | 33.37 | 24.10 | 64.3 | 33.37 | 24.15 | 64.5 | 33.37 | 24.20 | 64.6 | 33.37 | 24.25 | 64.8 | 33.37 | 24.30 | 64.9 | 33.37 | 24.35 | | | | | | |
| 9.90 | 63.6 | 33.41 | 23.87 | 63.8 | 33.41 | 23.92 | 63.9 | 33.41 | 23.97 | 64.1 | 33.41 | 24.02 | 64.2 | 33.41 | 24.07 | 64.4 | 33.41 | 24.12 | 64.5 | 33.41 | 24.17 | 64.6 | 33.41 | 24.22 | 64.8 | 33.41 | 24.27 | 64.9 | 33.41 | 24.32 | | | | | | |
| 10.00 | 63.7 | 33.44 | 23.84 | 63.8 | 33.44 | 23.89 | 64.0 | 33.44 | 23.94 | 64.1 | 33.44 | 23.99 | 64.2 | 33.44 | 24.04 | 64.4 | 33.44 | 24.09 | 64.5 | 33.44 | 24.14 | 64.7 | 33.44 | 24.19 | 64.8 | 33.44 | 24.24 | 65.0 | 33.44 | 24.29 | | | | | | |
| 10.10 | 63.7 | 33.48 | 23.81 | 63.8 | 33.48 | 23.86 | 64.0 | 33.48 | 23.91 | 64.1 | 33.48 | 23.96 | 64.3 | 33.48 | 24.01 | 64.4 | 33.48 | 24.06 | 64.5 | 33.48 | 24.11 | 64.7 | 33.48 | 24.16 | 64.8 | 33.48 | 24.21 | 65.0 | 33.48 | 24.26 | | | | | | |
| 10.20 | 63.7 | 33.52 | 23.78 | 63.9 | 33.52 | 23.83 | 64.0 | 33.52 | 23.88 | 64.1 | 33.52 | 23.93 | 64.3 | 33.52 | 23.98 | 64.4 | 33.52 | 24.03 | 64.6 | 33.52 | 24.08 | 64.7 | 33.52 | 24.13 | 64.9 | 33.52 | 24.18 | 65.0 | 33.52 | 24.23 | | | | | | |
| 10.30 | 63.7 | 33.56 | 23.75 | 63.9 | 33.56 | 23.80 | 64.0 | 33.56 | 23.85 | 64.2 | 33.56 | 23.90 | 64.3 | 33.56 | 23.95 | 64.5 | 33.56 | 24.00 | 64.6 | 33.56 | 24.05 | 64.7 | 33.56 | 24.10 | 64.9 | 33.56 | 24.15 | 65.0 | 33.56 | 24.20 | | | | | | |
| 10.40 | 63.8 | 33.59 | 23.72 | 63.9 | 33.59 | 23.77 | 64.0 | 33.59 | 23.82 | 64.2 | 33.59 | 23.87 | 64.3 | 33.59 | 23.92 | 64.5 | 33.59 | 23.97 | 64.6 | 33.59 | 24.02 | 64.8 | 33.59 | 24.07 | 64.9 | 33.59 | 24.12 | 65.1 | 33.59 | 24.17 | | | | | | |
| 10.50 | 63.8 | 33.63 | 23.69 | 63.9 | 33.63 | 23.74 | 64.1 | 33.63 | 23.79 | 64.2 | 33.63 | 23.84 | 64.4 | 33.63 | 23.89 | 64.5 | 33.63 | 23.94 | 64.6 | 33.63 | 23.99 | 64.8 | 33.63 | 24.04 | 64.9 | 33.63 | 24.09 | 65.1 | 33.63 | 24.15 | | | | | | |
| 10.60 | 63.8 | 33.67 | 23.66 | 63.9 | 33.67 | 23.71 | 64.1 | 33.67 | 23.76 | 64.2 | 33.67 | 23.81 | 64.4 | 33.67 | 23.86 | 64.5 | 33.67 | 23.91 | 64.7 | 33.67 | 23.96 | 64.8 | 33.67 | 24.02 | 65.0 | 33.67 | 24.07 | 65.1 | 33.67 | 24.12 | | | | | | |
| 10.70 | 63.8 | 33.71 | 23.63 | 64.0 | 33.71 | 23.68 | 64.1 | 33.71 | 23.73 | 64.3 | 33.71 | 23.78 | 64.4 | 33.71 | 23.83 | 64.5 | 33.71 | 23.88 | 64.7 | 33.71 | 23.94 | 64.8 | 33.71 | 23.99 | 65.0 | 33.71 | 24.04 | 65.1 | 33.71 | 24.09 | | | | | | |
| 10.80 | 63.8 | 33.74 | 23.60 | 64.0 | 33.74 | 23.65 | 64.1 | 33.74 | 23.70 | 64.3 | 33.74 | 23.75 | 64.4 | 33.74 | 23.80 | 64.6 | 33.74 | 23.86 | 64.7 | 33.74 | 23.91 | 64.9 | 33.74 | 23.96 | 65.0 | 33.74 | 24.01 | 65.1 | 33.74 | 24.06 | | | | | | |
| 10.90 | 63.9 | 33.78 | 23.57 | 64.0 | 33.78 | 23.62 | 64.2 | 33.78 | 23.67 | 64.3 | 33.78 | 23.72 | 64.4 | 33.78 | 23.77 | 64.6 | 33.78 | 23.83 | 64.7 | 33.78 | 23.88 | 64.9 | 33.78 | 23.93 | 65.0 | 33.78 | 23.98 | 65.2 | 33.78 | 24.03 | | | | | | |
| 11.00 | 63.9 | 33.82 | 23.54 | 64.0 | 33.82 | 23.59 | 64.2 | 33.82 | 23.64 | 64.3 | 33.82 | 23.69 | 64.5 | 33.82 | 23.74 | 64.6 | 33.82 | 23.80 | 64.8 | 33.82 | 23.85 | 64.9 | 33.82 | 23.90 | 65.1 | 33.82 | 23.95 | 65.2 | 33.82 | 24.00 | | | | | | |
| 11.10 | 63.9 | 33.86 | 23.51 | 64.1 | 33.86 | 23.56 | 64.2 | 33.86 | 23.61 | 64.4 | 33.86 | 23.66 | 64.5 | 33.86 | 23.72 | 64.6 | 33.86 | 23.77 | 64.8 | 33.86 | 23.82 | 64.9 | 33.86 | 23.87 | 65.1 | 33.86 | 23.92 | 65.2 | 33.86 | 23.97 | | | | | | |
| 11.20 | 63.9 | 33.90 | 23.48 | 64.1 | 33.90 | 23.53 | 64.2 | 33.90 | 23.58 | 64.4 | 33.90 | 23.63 | 64.5 | 33.90 | 23.69 | 64.7 | 33.90 | 23.74 | 64.8 | 33.90 | 23.79 | 65.0 | 33.90 | 23.84 | 65.1 | 33.90 | 23.89 | 65.2 | 33.90 | 23.94 | | | | | | |
| 11.30 | 64.0 | 33.93 | 23.45 | 64.1 | 33.93 | 23.50 | 64.3 | 33.93 | 23.55 | 64.4 | 33.93 | 23.60 | 64.5 | 33.93 | 23.66 | 64.7 | 33.93 | 23.71 | 64.8 | 33.93 | 23.76 | 65.0 | 33.93 | 23.81 | 65.1 | 33.93 | 23.86 | 65.3 | 33.93 | 23.91 | | | | | | |
| 11.40 | 64.0 | 33.97 | 23.42 | 64.1 | 33.97 | 23.47 | 64.3 | 33.97 | 23.52 | 64.4 | 33.97 | 23.57 | 64.6 | 33.97 | 23.63 | 64.7 | 33.97 | 23.68 | 64.9 | 33.97 | 23.73 | 65.0 | 33.97 | 23.78 | 65.1 | 33.97 | 23.83 | 65.3 | 33.97 | 23.88 | | | | | | |
| 11.50 | 64.0 | 34.01 | 23.39 | 64.2 | 34.01 | 23.44 | 64.3 | 34.01 | 23.49 | 64.4 | 34.01 | 23.54 | 64.6 | 34.01 | 23.60 | 64.7 | 34.01 | 23.65 | 64.9 | 34.01 | 23.70 | 65.0 | 34.01 | 23.75 | 65.2 | 34.01 | 23.80 | 65.3 | 34.01 | 23.85 | | | | | | |
| 11.60 | 64.0 | 34.05 | 23.36 | 64.2 | 34.05 | 23.41 | 64.3 | 34.05 | 23.46 | 64.5 | 34.05 | 23.51 | 64.6 | 34.05 | 23.56 | 64.8 | 34.05 | 23.62 | 64.9 | 34.05 | 23.67 | 65.1 | 34.05 | 23.72 | 65.2 | 34.05 | 23.77 | 65.3 | 34.05 | 23.82 | | | | | | |
| 11.70 | 64.1 | 34.09 | 23.33 | 64.2 | 34.09 | 23.38 | 64.3 | 34.09 | 23.43 | 64.5 | 34.09 | 23.48 | 64.6 | 34.09 | 23.53 | 64.8 | 34.09 | 23.59 | 64.9 | 34.09 | 23.64 | 65.1 | 34.09 | 23.69 | 65.2 | 34.09 | 23.74 | 65.4 | 34.09 | 23.79 | | | | | | |
| 11.80 | 64.1 | 34.13 | 23.30 | 64.2 | 34.13 | 23.35 | 64.4 | 34.13 | 23.40 | 64.5 | 34.13 | 23.45 | 64.7 | 34.13 | 23.50 | 64.8 | 34.13 | 23.56 | 65.0 | 34.13 | 23.61 | 65.1 | 34.13 | 23.66 | 65.2 | 34.13 | 23.71 | 65.4 | 34.13 | 23.76 | | | | | | |
| 11.90 | 64.1 | 34.17 | 23.27 | 64.2 | 34.17 | 23.32 | 64.4 | 34.17 | 23.37 | 64.5 | 34.17 | 23.42 | 64.7 | 34.17 | 23.47 | 64.8 | 34.17 | 23.53 | 65.0 | 34.17 | 23.58 | 65.1 | 34.17 | 23.63 | 65.3 | 34.17 | 23.68 | 65.4 | 34.17 | 23.73 | | | | | | |
| 12.00 | 64.1 | 34.20 | 23.24 | 64.3 | 34.20 | 23.29 | 64.4 | 34.20 | 23.34 | 64.6 | 34.20 | 23.39 | 64.7 | 34.20 | 23.44 | 64.9 | 34.20 | 23.49 | 65.0 | 34.20 | 23.55 | 65.1 | 34.20 | 23.60 | 65.3 | 34.20 | 23.65 | 65.4 | 34.20 | 23.70 | | | | | | |
| 12.10 | 64.1 | 34.24 | 23.21 | 64.3 | 34.24 | 23.26 | 64.4 | 34.24 | 23.31 | 64.6 | 34.24 | 23.36 | 64.7 | 34.24 | 23.41 | 64.9 | 34.24 | 23.46 | 65.0 | 34.24 | 23.52 | 65.2 | 34.24 | 23.57 | 65.3 | 34.24 | 23.62 | 65.5 | 34.24 | 23.67 | | | | | | |
| 12.30 | 64.2 | 34.32 | 23.15 | 64.3 | 34.32 | 23.20 | 64.5 | 34.32 | 23.25 | 64.6 | 34.32 | 23.30 | 64.8 | 34.32 | 23.35 | 64.9 | 34.32 | 23.40 | 65.1 | 34.32 | 23.45 | 65.2 | 34.32 | 23.51 | 65.4 | 34.32 | 23.56 | 65.5 | 34.32 | 23.61 | | | | | | |
| 12.30 | 64.2 | 34.32 | 23.15 | 64.3 | 34.32 | 23.20 | 64.5 | 34.32 | 23.25 | 64.6 | 34.32 | 23.30 | 64.8 | 34.32 | 23.35 | 64.9 | 34.32 | 23.40 | 65.1 | 34.32 | 23.45 | 65.2 | 34.32 | 23.51 | 65.4 | 34.32 | 23.56 | 65.5 | 34.32 | 23.61 | | | | | | |
| 12.40 | 64.2 | 34.36 | 23.12 | 64.4 | 34.36 | 23.17 | 64.5 | 34.36 | 23.22 | 64.7 | 34.36 | 23.27 | 64.8 | 34.36 | 23.32 | 65.0 | 34.36 | 23.37 | 65.1 | 34.36 | 23.42 | 65.2 | 34.36 | 23.48 | 65.4 | 34.36 | 23.53 | 65.5 | 34.36 | 23.58 | | | | | | |
| 12.50 | 64.2 | 34.40 | 23.08 | 64.4 | 34.40 | 23.14 | 64.5 | 34.40 | 23.19 | 64.7 | 34.40 | 23.24 | 64.8 | 34.40 | 23.29 | 65.0 | 34.40 | 23.34 | 65.1 | 34.40 | 23.39 | 65.3 | 34.40 | 23.45 | 65.4 | 34.40 | 23.50 | 65.6 | 34.40 | 23.55 | | | | | | |
| 12.60 | 64.3 | 34.44 | 23.05 | 64.4 | 34.44 | 23.10 | 64.6 | 34.44 | 23.16 | 64.7 | 34.44 | 23.21 | 64.9 | 34.44 | 23.26 | 65.0 | 34.44 | 23.31 | 65.1 | 34.44 | 23.36 | 65.3 | 34.44 | 23.41 | 65.4 | 34.44 | 23.47 | 65.6 | 34.44 | 23.52 | | | | | | |
| 12.70 | 64.3 | 34.48 | 23.02 | 64.4 | 34.48 | 23.07 | 64.6 | 34.48 | 23.13 | 64.7 | 34.48 | 23.18 | 64.9 | 34.48 | 23.23 | 65.0 | 34.48 | 23.28 | 65.2 | 34.48 | 23.33 | 65.3 | 34.48 | 23.38 | 65.5 | 34.48 | 23.44 | 65.6 | 34.48 | 23.49 | | | | | | |
| 12.80 | 64.3 | 34.52 | 22.99 | 64.5 | 34.52 | 23.04 | 64.6 | 34.52 | 23.09 | 64.8 | 34.52 | 23.15 | 64.9 | 34.52 | 23.20 | 65.1 | 34.52 | 23.25 | 65.2 | 34.52 | 23.30 | 65.3 | 34.52 | 23.35 | 65.5 | 34.52 | 23.40 | 65.6 | 34.52 | 23.46 | | | | | | |
| 12.90 | 64.3 | 34.56 | 22.96 | 64.5 | 34.56 | 23.01 | 64.6 | 34.56 | 23.06 | 64.8 | 34.56 | 23.11 | 64.9 | 34.56 | 23.17 | 65.1 | 34.56 | 23.22 | 65.2 | 34.56 | 23.27 | 65.4 | 34.56 | 23.32 | 65.5 | 34.56 | 23.37 | 65.7 | 34.56 | 23.43 | | | | | | |
| 13.00 | 64.4 | 34.60 | 22.93 | 64.5 | 34.60 | 22.98 | 64.7 | 34.60 | 23.03 | 64.8 | 34.60 | 23.08 | 65.0 | 34.60 | 23.14 | 65.1 | 34.60 | 23.19 | 65.2 | 34.60 | 23.24 | 65.4 | 34.60 | 23.29 | 65.5 | 34.60 | 23.34 | 65.7 | 34.60 | 23.39 | | | | | | |
| 13.10 | 64.4 | 34.64 | 22.90 | 64.5 | 34.64 | 22.95 | 64.7 | 34.64 | 23.00 | 64.8 | 34.64 | 23.05 | 65.0 | 34.64 | 23.10 | 65.1 | 34.64 | 23.16 | 65.3 | 34.64 | 23.21 | 65.4 | 34.64 | 23.26 | 65.6 | 34.64 | 23.31 | 65.7 | 34.64 | 23.36 | | | | | | |
| 13.20 | 64.4 | 34.68 | 22.86 | 64.6 | 34.68 | 22.92 | 64.7 | 34.68 | 22.97 | 64.9 | 34.68 | 23.02 | 65.0 | 34.68 | 23.07 | 65.1 | 34.68 | 23.12 | 65.3 | 34.68 | 23.18 | 65.4 | 34.68 | 23.23 | 65.6 | 34.68 | 23.28 | 65.7 | 34.68 | 23.33 | | | | | | |
| 13.30 | 64.4 | 34.72 | 22.83 | 64.6 | 34.72 | 22.89 | 64.7 | 34.72 | 22.94 | 64.9 | 34.72 | 22.99 | 65.0 | 34.72 | 23.04 | 65.2 | 34.72 | 23.09 | 65.3 | 34.72 | 23.15 | 65.5 | 34.72 | 23.20 | 65.6 | 34.72 | 23.25 | 65.8 | 34.72 | 23.30 | | | | | | |
| 13.40 | 64.5 | 34.76 | 22.80 | 64.6 | 34.76 | 22.85 | 64.8 | 34.76 | 22.91 | 64.9 | 34.76 | 22.96 | 65.1 | 34.76 | 23.01 | 65.2 | 34.76 | 23.06 | 65.3 | 34.76 | 23.11 | 65.5 | 34.76 | 23.17 | 65.6 | 34.76 | 23.22 | 65.8 | 34.76 | 23.27 | | | | | | |
| 13.50 | 64.5 | 34.80 | 22.77 | 64.6 | 34.80 | 22.82 | 64.8 | 34.80 | 22.87 | 64.9 | 34.80 | 22.93 | 65.1 | 34.80 | 22.98 | 65.2 | 34.80 | 23.03 | 65.4 | 34.80 | 23.08 | 65.5 | 34.80 | 23.14 | 65.7 | 34.80 | 23.19 | 65.8 | 34.80 | 23.24 | | | | | | |
| 13.60 | 64.5 | 34.84 | 22.74 | 64.7 | 34.84 | 22.79 | 64.8 | 34.84 | 22.84 | 65.0 | 34.84 | 22.89 | 65.1 | 34.84 | 22.95 | 65.2 | 34.84 | 23.00 | 65.4 | 34.84 | 23.05 | 65.5 | 34.84 | 23.10 | 65.7 | 34.84 | 23.16 | 65.8 | 34.84 | 23.21 | | | | | | |
| 13.70 | 64.5 | 34.88 | 22.71 | 64.7 | 34.88 | 22.76 | 64.8 | 34.88 | 22.81 | 65.0 | 34.88 | 22.86 | 65.1 | 34.88 | 22.92 | 65.3 | 34.88 | 22.97 | 65.4 | 34.88 | 23.02 | 65.6 | 34.88 | 23.07 | 65.7 | 34.88 | 23.12 | 65.9 | 34.88 | 23.18 | | | | | | |
| 13.80 | 64.6 | 34.92 | 22.67 | 64.7 | 34.92 | 22.73 | 64.9 | 34.92 | 22.78 | 65.0 | 34.92 | 22.83 | 65.1 | 34.92 | 22.88 | 65.3 | 34.92 | 22.94 | 65.4 | 34.92 | 22.99 | 65.6 | 34.92 | 23.04 | 65.7 | 34.92 | 23.09 | 65.9 | 34.92 | 23.15 | | | | | | |
| 13.90 | 64.6 | 34.96 | 22.64 | 64.7 | 34.96 | 22.69 | 64.9 | 34.96 | 22.75 | 65.0 | 34.96 | 22.80 | 65.2 | 34.96 | 22.85 | 65.3 | 34.96 | 22.90 | 65.5 | 34.96 | 22.96 | 65.6 | 34.96 | 23.01 | 65.8 | 34.96 | 23.06 | 65.9 | 34.96 | 23.11 | | | | | | |
| 14.00 | 64.6 | 35.00 | 22.61 | 64.8 | 35.00 | 22.66 | 64.9 | 35.00 | 22.72 | 65.1 | 35.00 | 22.77 | 65.2 | 35.00 | 22.82 | 65.4 | 35.00 | 22.87 | 65.5 | 35.00 | 22.93 | 65.7 | 35.00 | 22.98 | 65.8 | 35.00 | 23.03 | 66.0 | 35.00 | 23.08 | | | | | | |
| 14.10 | 64.6 | 35.04 | 22.58 | 64.8 | 35.04 | 22.63 | 64.9 | 35.04 | 22.68 | 65.1 | 35.04 | 22.74 | 65.2 | 35.04 | 22.79 | 65.4 | 35.04 | 22.84 | 65.5 | 35.04 | 22.89 | 65.7 | 35.04 | 22.95 | 65.8 | 35.04 | 23.00 | 66.0 | 35.04 | 23.05 | | | | | | |
| 14.20 | 64.6 | 35.08 | 22.55 | 64.8 | 35.08 | 22.60 | 64.9 | 35.08 | 22.65 | 65.1 | 35.08 | 22.70 | 65.3 | 35.08 | 22.76 | 65.4 | 35.08 | 22.81 | 65.6 | 35.08 | 22.86 | 65.7 | 35.08 | 22.91 | 65.9 | 35.08 | 22.97 | 66.0 | 35.08 | 23.02 | | | | | | |
| 14.30 | 64.7 | 35.12 | 22.51 | 64.8 | 35.12 | 22.57 | 65.0 | 35.12 | 22.62 | 65.1 | 35.12 | 22.67 | 65.3 | 35.12 | 22.72 | 65.4 | 35.12 | 22.78 | 65.6 | 35.12 | 22.83 | 65.7 | 35.12 | 22.88 | 65.9 | 35.12 | 22.93 | 66.0 | 35.12 | 22.99 | | | | | | |
| 14.40 | 64.7 | 35.16 | 22.48 | 64.8 | 35.16 | 22.53 | 65.0 | 35.16 | 22.59 | 65.2 | 35.16 | 22.64 | 65.3 | 35.16 | 22.69 | 65.5 | 35.16 | 22.74 | 65.6 | 35.16 | 22.80 | 65.8 | 35.16 | 22.85 | 65.9 | 35.16 | 22.90 | 66.1 | 35.16 | 22.96 | | | | | | |
| 14.50 | 64.7 | 35.20 | 22.45 | 64.9 | 35.20 | 22.50 | 65.0 | 35.20 | 22.55 | 65.2 | 35.20 | 22.61 | 65.3 | 35.20 | 22.66 | 65.5 | 35.20 | 22.71 | 65.6 | 35.20 | 22.77 | 65.8 | 35.20 | 22.82 | 65.9 | 35.20 | 22.87 | 66.1 | 35.20 | 22.92 | | | | | | |
| 14.60 | 64.7 | 35.25 | 22.42 | 64.9 | 35.25 | 22.47 | 65.0 | 35.25 | 22.52 | 65.2 | 35.25 | 22.57 | 65.4 | 35.25 | 22.63 | 65.5 | 35.25 | 22.68 | 65.7 | 35.25 | 22.73 | 65.8 | 35.25 | 22.79 | 66.0 | 35.25 | 22.84 | 66.1 | 35.25 | 22.89 | | | | | | |
| 14.70 | 64.8 | 35.29 | 22.38 | 64.9 | 35.29 | 22.44 | 65.1 | 35.29 | 22.49 | 65.2 | 35.29 | 22.54 | 65.4 | 35.29 | 22.59 | 65.5 | 35.29 | 22.65 | 65.7 | 35.29 | 22.70 | 65.8 | 35.29 | 22.75 | 66.0 | 35.29 | 22.81 | 66.1 | 35.29 | 22.86 | | | | | | |
| 14.80 | 64.8 | 35.33 | 22.35 | 64.9 | 35.33 | 22.40 | 65.1 | 35.33 | 22.46 | 65.3 | 35.33 | 22.51 | 65.4 | 35.33 | 22.56 | 65.6 | 35.33 | 22.62 | 65.7 | 35.33 | 22.67 | 65.9 | 35.33 | 22.72 | 66.0 | 35.33 | 22.77 | 66.2 | 35.33 | 22.83 | | | | | | |
| 14.90 | 64.8 | 35.37 | 22.32 | 65.0 | 35.37 | 22.37 | 65.1 | 35.37 | 22.42 | 65.3 | 35.37 | 22.48 | 65.4 | 35.37 | 22.53 | 65.6 | 35.37 | 22.58 | 65.7 | 35.37 | 22.64 | 65.9 | 35.37 | 22.69 | 66.0 | 35.37 | 22.74 | 66.2 | 35.37 | 22.80 | | | | | | |
| 15.00 | 64.8 | 35.41 | 22.28 | 65.0 | 35.41 | 22.34 | 65.2 | 35.41 | 22.39 | 65.3 | 35.41 | 22.44 | 65.5 | 35.41 | 22.50 | 65.6 | 35.41 | 22.55 | 65.8 | 35.41 | 22.60 | 65.9 | 35.41 | 22.66 | 66.1 | 35.41 | 22.71 | 66.2 | 35.41 | 22.76 | | | | | | |
| 15.10 | 64.9 | 35.45 | 22.25 | 65.0 | 35.45 | 22.30 | 65.2 | 35.45 | 22.36 | 65.3 | 35.45 | 22.41 | 65.5 | 35.45 | 22.46 | 65.6 | 35.45 | 22.52 | 65.8 | 35.45 | 22.57 | 65.9 | 35.45 | 22.62 | 66.1 | 35.45 | 22.68 | 66.2 | 35.45 | 22.73 | | | | | | |
| 15.20 | 64.9 | 35.50 | 22.22 | 65.0 | 35.50 | 22.27 | 65.2 | 35.50 | 22.33 | 65.4 | 35.50 | 22.38 | 65.5 | 35.50 | 22.43 | 65.7 | 35.50 | 22.48 | 65.8 | 35.50 | 22.54 | 66.0 | 35.50 | 22.59 | 66.1 | 35.50 | 22.64 | 66.3 | 35.50 | 22.70 | | | | | | |
| 15.30 | 64.9 | 35.54 | 22.19 | 65.1 | 35.54 | 22.24 | 65.2 | 35.54 | 22.29 | 65.4 | 35.54 | 22.35 | 65.5 | 35.54 | 22.40 | 65.7 | 35.54 | 22.45 | 65.8 | 35.54 | 22.51 | 66.0 | 35.54 | 22.56 | 66.1 | 35.54 | 22.61 | 66.3 | 35.54 | 22.67 | | | | | | |
| 15.40 | 64.9 | 35.58 | 22.15 | 65.1 | 35.58 | 22.21 | 65.3 | 35.58 | 22.26 | 65.4 | 35.58 | 22.31 | 65.6 | 35.58 | 22.37 | 65.7 | 35.58 | 22.42 | 65.9 | 35.58 | 22.47 | 66.0 | 35.58 | 22.53 | 66.2 | 35.58 | 22.58 | 66.3 | 35.58 | 22.63 | | | | | | |
| 15.50 | 65.0 | 35.62 | 22.12 | 65.1 | 35.62 | 22.17 | 65.3 | 35.62 | 22.23 | 65.4 | 35.62 | 22.28 | 65.6 | 35.62 | 22.33 | 65.7 | 35.62 | 22.39 | 65.9 | 35.62 | 22.44 | 66.0 | 35.62 | 22.49 | 66.2 | 35.62 | 22.55 | 66.3 | 35.62 | 22.60 | | | | | | |
| 15.60 | 65.0 | 35.66 | 22.09 | 65.2 | 35.66 | 22.14 | 65.3 | 35.66 | 22.19 | 65.5 | 35.66 | 22.25 | 65.6 | 35.66 | 22.30 | 65.8 | 35.66 | 22.35 | 65.9 | 35.66 | 22.41 | 66.1 | 35.66 | 22.46 | 66.2 | 35.66 | 22.51 | 66.4 | 35.66 | 22.57 | | | | | | |
| 15.70 | 65.0 | 35.71 | 22.05 | 65.2 | 35.71 | 22.11 | 65.3 | 35.71 | 22.16 | 65.5 | 35.71 | 22.21 | 65.6 | 35.71 | 22.27 | 65.8 | 35.71 | 22.32 | 65.9 | 35.71 | 22.37 | 66.1 | 35.71 | 22.43 | 66.2 | 35.71 | 22.48 | 66.4 | 35.71 | 22.53 | | | | | | |
| 15.80 | 65.0 | 35.75 | 22.02 | 65.2 | 35.75 | 22.07 | 65.4 | 35.75 | 22.13 | 65.5 | 35.75 | 22.18 | 65.7 | 35.75 | 22.23 | 65.8 | 35.75 | 22.29 | 66.0 | 35.75 | 22.34 | 66.1 | 35.75 | 22.39 | 66.3 | 35.75 | 22.45 | 66.4 | 35.75 | 22.50 | | | | | | |
| 15.90 | 65.1 | 35.79 | 21.99 | 65.2 | 35.79 | 22.04 | 65.4 | 35.79 | 22.09 | 65.5 | 35.79 | 22.15 | 65.7 | 35.79 | 22.20 | 65.8 | 35.79 | 22.25 | 66.0 | 35.79 | 22.31 | 66.1 | 35.79 | 22.36 | 66.3 | 35.79 | 22.41 | 66.5 | 35.79 | 22.47 | | | | | | |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 35.0; Water (ml) = (% Absorption x 35.0 / 100) + (35.0 - sample weight)

## 35-gram Mixograph: Absorption, Flour and Water Amount Table
## (15.0 - 15.9% protein level)

| Moist | Protein Content (as is, %) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Content | 15.00 | | | 15.10 | | | 15.20 | | | 15.30 | | | 15.40 | | | 15.50 | | | 15.60 | | | 15.70 | | | 15.80 | | | 15.90 | | | | | | | | | |
| as is | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | ABS | flour | water | | | | | | |
| % | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | % | g | ml | | | | | | |
| 9.00 | 64.9 | 33.08 | 24.63 | 65.0 | 33.08 | 24.68 | 65.1 | 33.08 | 24.72 | 65.3 | 33.08 | 24.77 | 65.4 | 33.08 | 24.82 | 65.6 | 33.08 | 24.87 | 65.7 | 33.08 | 24.92 | 65.9 | 33.08 | 24.97 | 66.0 | 33.08 | 25.02 | 66.1 | 33.08 | 25.07 | | | | | | |
| 9.10 | 64.9 | 33.11 | 24.60 | 65.0 | 33.11 | 24.65 | 65.2 | 33.11 | 24.70 | 65.3 | 33.11 | 24.75 | 65.5 | 33.11 | 24.80 | 65.6 | 33.11 | 24.85 | 65.7 | 33.11 | 24.90 | 65.9 | 33.11 | 24.94 | 66.0 | 33.11 | 24.99 | 66.2 | 33.11 | 25.04 | | | | | | |
| 9.20 | 64.9 | 33.15 | 24.57 | 65.1 | 33.15 | 24.62 | 65.2 | 33.15 | 24.67 | 65.3 | 33.15 | 24.72 | 65.5 | 33.15 | 24.77 | 65.6 | 33.15 | 24.82 | 65.8 | 33.15 | 24.87 | 65.9 | 33.15 | 24.92 | 66.0 | 33.15 | 24.97 | 66.2 | 33.15 | 25.02 | | | | | | |
| 9.30 | 64.9 | 33.19 | 24.54 | 65.1 | 33.19 | 24.59 | 65.2 | 33.19 | 24.64 | 65.4 | 33.19 | 24.69 | 65.5 | 33.19 | 24.74 | 65.6 | 33.19 | 24.79 | 65.8 | 33.19 | 24.84 | 65.9 | 33.19 | 24.89 | 66.1 | 33.19 | 24.94 | 66.2 | 33.19 | 24.99 | | | | | | |
| 9.40 | 65.0 | 33.22 | 24.51 | 65.1 | 33.22 | 24.56 | 65.2 | 33.22 | 24.61 | 65.4 | 33.22 | 24.66 | 65.5 | 33.22 | 24.71 | 65.7 | 33.22 | 24.76 | 65.8 | 33.22 | 24.81 | 66.0 | 33.22 | 24.86 | 66.1 | 33.22 | 24.91 | 66.2 | 33.22 | 24.96 | | | | | | |
| 9.50 | 65.0 | 33.26 | 24.48 | 65.1 | 33.26 | 24.53 | 65.3 | 33.26 | 24.58 | 65.4 | 33.26 | 24.63 | 65.6 | 33.26 | 24.68 | 65.7 | 33.26 | 24.73 | 65.8 | 33.26 | 24.78 | 66.0 | 33.26 | 24.83 | 66.1 | 33.26 | 24.88 | 66.3 | 33.26 | 24.93 | | | | | | |
| 9.60 | 65.0 | 33.30 | 24.46 | 65.1 | 33.30 | 24.51 | 65.3 | 33.30 | 24.56 | 65.4 | 33.30 | 24.61 | 65.6 | 33.30 | 24.66 | 65.7 | 33.30 | 24.70 | 65.9 | 33.30 | 24.75 | 66.0 | 33.30 | 24.80 | 66.1 | 33.30 | 24.85 | 66.3 | 33.30 | 24.90 | | | | | | |
| 9.70 | 65.0 | 33.33 | 24.43 | 65.2 | 33.33 | 24.48 | 65.3 | 33.33 | 24.53 | 65.5 | 33.33 | 24.58 | 65.6 | 33.33 | 24.63 | 65.7 | 33.33 | 24.68 | 65.9 | 33.33 | 24.73 | 66.0 | 33.33 | 24.78 | 66.2 | 33.33 | 24.83 | 66.3 | 33.33 | 24.88 | | | | | | |
| 9.80 | 65.1 | 33.37 | 24.40 | 65.2 | 33.37 | 24.45 | 65.3 | 33.37 | 24.50 | 65.5 | 33.37 | 24.55 | 65.6 | 33.37 | 24.60 | 65.8 | 33.37 | 24.65 | 65.9 | 33.37 | 24.70 | 66.1 | 33.37 | 24.75 | 66.2 | 33.37 | 24.80 | 66.3 | 33.37 | 24.85 | | | | | | |
| 9.90 | 65.1 | 33.41 | 24.37 | 65.2 | 33.41 | 24.42 | 65.4 | 33.41 | 24.47 | 65.5 | 33.41 | 24.52 | 65.6 | 33.41 | 24.57 | 65.8 | 33.41 | 24.62 | 65.9 | 33.41 | 24.67 | 66.1 | 33.41 | 24.72 | 66.2 | 33.41 | 24.77 | 66.4 | 33.41 | 24.82 | | | | | | |
| 10.00 | 65.1 | 33.44 | 24.34 | 65.2 | 33.44 | 24.39 | 65.4 | 33.44 | 24.44 | 65.5 | 33.44 | 24.49 | 65.7 | 33.44 | 24.54 | 65.8 | 33.44 | 24.59 | 66.0 | 33.44 | 24.64 | 66.1 | 33.44 | 24.69 | 66.2 | 33.44 | 24.74 | 66.4 | 33.44 | 24.79 | | | | | | |
| 10.10 | 65.1 | 33.48 | 24.31 | 65.3 | 33.48 | 24.36 | 65.4 | 33.48 | 24.41 | 65.6 | 33.48 | 24.46 | 65.7 | 33.48 | 24.51 | 65.8 | 33.48 | 24.56 | 66.0 | 33.48 | 24.61 | 66.1 | 33.48 | 24.66 | 66.3 | 33.48 | 24.71 | 66.4 | 33.48 | 24.76 | | | | | | |
| 10.20 | 65.1 | 33.52 | 24.28 | 65.3 | 33.52 | 24.33 | 65.4 | 33.52 | 24.38 | 65.6 | 33.52 | 24.43 | 65.7 | 33.52 | 24.48 | 65.9 | 33.52 | 24.53 | 66.0 | 33.52 | 24.58 | 66.2 | 33.52 | 24.63 | 66.3 | 33.52 | 24.69 | 66.4 | 33.52 | 24.74 | | | | | | |
| 10.30 | 65.2 | 33.56 | 24.25 | 65.3 | 33.56 | 24.30 | 65.5 | 33.56 | 24.35 | 65.6 | 33.56 | 24.40 | 65.7 | 33.56 | 24.46 | 65.9 | 33.56 | 24.51 | 66.0 | 33.56 | 24.56 | 66.2 | 33.56 | 24.61 | 66.3 | 33.56 | 24.66 | 66.5 | 33.56 | 24.71 | | | | | | |
| 10.40 | 65.2 | 33.59 | 24.22 | 65.3 | 33.59 | 24.28 | 65.5 | 33.59 | 24.33 | 65.6 | 33.59 | 24.38 | 65.8 | 33.59 | 24.43 | 65.9 | 33.59 | 24.48 | 66.1 | 33.59 | 24.53 | 66.2 | 33.59 | 24.58 | 66.3 | 33.59 | 24.63 | 66.5 | 33.59 | 24.68 | | | | | | |
| 10.50 | 65.2 | 33.63 | 24.20 | 65.4 | 33.63 | 24.25 | 65.5 | 33.63 | 24.30 | 65.7 | 33.63 | 24.35 | 65.8 | 33.63 | 24.40 | 65.9 | 33.63 | 24.45 | 66.1 | 33.63 | 24.50 | 66.2 | 33.63 | 24.55 | 66.4 | 33.63 | 24.60 | 66.5 | 33.63 | 24.65 | | | | | | |
| 10.60 | 65.2 | 33.67 | 24.17 | 65.4 | 33.67 | 24.22 | 65.5 | 33.67 | 24.27 | 65.7 | 33.67 | 24.32 | 65.8 | 33.67 | 24.37 | 66.0 | 33.67 | 24.42 | 66.1 | 33.67 | 24.47 | 66.3 | 33.67 | 24.52 | 66.4 | 33.67 | 24.57 | 66.5 | 33.67 | 24.62 | | | | | | |
| 10.70 | 65.3 | 33.71 | 24.14 | 65.4 | 33.71 | 24.19 | 65.6 | 33.71 | 24.24 | 65.7 | 33.71 | 24.29 | 65.8 | 33.71 | 24.34 | 66.0 | 33.71 | 24.39 | 66.1 | 33.71 | 24.44 | 66.3 | 33.71 | 24.49 | 66.4 | 33.71 | 24.54 | 66.6 | 33.71 | 24.59 | | | | | | |
| 10.80 | 65.3 | 33.74 | 24.11 | 65.4 | 33.74 | 24.16 | 65.6 | 33.74 | 24.21 | 65.7 | 33.74 | 24.26 | 65.9 | 33.74 | 24.31 | 66.0 | 33.74 | 24.36 | 66.2 | 33.74 | 24.41 | 66.3 | 33.74 | 24.46 | 66.4 | 33.74 | 24.51 | 66.6 | 33.74 | 24.56 | | | | | | |
| 10.90 | 65.3 | 33.78 | 24.08 | 65.5 | 33.78 | 24.13 | 65.6 | 33.78 | 24.18 | 65.8 | 33.78 | 24.23 | 65.9 | 33.78 | 24.28 | 66.0 | 33.78 | 24.33 | 66.2 | 33.78 | 24.38 | 66.3 | 33.78 | 24.43 | 66.5 | 33.78 | 24.48 | 66.6 | 33.78 | 24.53 | | | | | | |
| 11.00 | 65.3 | 33.82 | 24.05 | 65.5 | 33.82 | 24.10 | 65.6 | 33.82 | 24.15 | 65.8 | 33.82 | 24.20 | 65.9 | 33.82 | 24.25 | 66.1 | 33.82 | 24.30 | 66.2 | 33.82 | 24.35 | 66.4 | 33.82 | 24.40 | 66.5 | 33.82 | 24.46 | 66.6 | 33.82 | 24.51 | | | | | | |
| 11.10 | 65.4 | 33.86 | 24.02 | 65.5 | 33.86 | 24.07 | 65.7 | 33.86 | 24.12 | 65.8 | 33.86 | 24.17 | 65.9 | 33.86 | 24.22 | 66.1 | 33.86 | 24.27 | 66.2 | 33.86 | 24.32 | 66.4 | 33.86 | 24.38 | 66.5 | 33.86 | 24.43 | 66.7 | 33.86 | 24.48 | | | | | | |
| 11.20 | 65.4 | 33.90 | 23.99 | 65.5 | 33.90 | 24.04 | 65.7 | 33.90 | 24.09 | 65.8 | 33.90 | 24.14 | 66.0 | 33.90 | 24.19 | 66.1 | 33.90 | 24.24 | 66.3 | 33.90 | 24.30 | 66.4 | 33.90 | 24.35 | 66.6 | 33.90 | 24.40 | 66.7 | 33.90 | 24.45 | | | | | | |
| 11.30 | 65.4 | 33.93 | 23.96 | 65.6 | 33.93 | 24.01 | 65.7 | 33.93 | 24.06 | 65.9 | 33.93 | 24.11 | 66.0 | 33.93 | 24.16 | 66.1 | 33.93 | 24.22 | 66.3 | 33.93 | 24.27 | 66.4 | 33.93 | 24.32 | 66.6 | 33.93 | 24.37 | 66.7 | 33.93 | 24.42 | | | | | | |
| 11.40 | 65.4 | 33.97 | 23.93 | 65.6 | 33.97 | 23.98 | 65.7 | 33.97 | 24.03 | 65.9 | 33.97 | 24.08 | 66.0 | 33.97 | 24.13 | 66.2 | 33.97 | 24.19 | 66.3 | 33.97 | 24.24 | 66.5 | 33.97 | 24.29 | 66.6 | 33.97 | 24.34 | 66.8 | 33.97 | 24.39 | | | | | | |
| 11.50 | 65.5 | 34.01 | 23.90 | 65.6 | 34.01 | 23.95 | 65.8 | 34.01 | 24.00 | 65.9 | 34.01 | 24.05 | 66.0 | 34.01 | 24.11 | 66.2 | 34.01 | 24.16 | 66.3 | 34.01 | 24.21 | 66.5 | 34.01 | 24.26 | 66.6 | 34.01 | 24.31 | 66.8 | 34.01 | 24.36 | | | | | | |
| 11.60 | 65.5 | 34.05 | 23.87 | 65.6 | 34.05 | 23.92 | 65.8 | 34.05 | 23.97 | 65.9 | 34.05 | 24.02 | 66.1 | 34.05 | 24.08 | 66.2 | 34.05 | 24.13 | 66.4 | 34.05 | 24.18 | 66.5 | 34.05 | 24.23 | 66.7 | 34.05 | 24.28 | 66.8 | 34.05 | 24.33 | | | | | | |
| 11.70 | 65.5 | 34.09 | 23.84 | 65.7 | 34.09 | 23.89 | 65.8 | 34.09 | 23.94 | 66.0 | 34.09 | 23.99 | 66.1 | 34.09 | 24.05 | 66.2 | 34.09 | 24.10 | 66.4 | 34.09 | 24.15 | 66.5 | 34.09 | 24.20 | 66.7 | 34.09 | 24.25 | 66.8 | 34.09 | 24.30 | | | | | | |
| 11.80 | 65.5 | 34.13 | 23.81 | 65.7 | 34.13 | 23.86 | 65.8 | 34.13 | 23.91 | 66.0 | 34.13 | 23.97 | 66.1 | 34.13 | 24.02 | 66.3 | 34.13 | 24.07 | 66.4 | 34.13 | 24.12 | 66.6 | 34.13 | 24.17 | 66.7 | 34.13 | 24.22 | 66.9 | 34.13 | 24.27 | | | | | | |
| 11.90 | 65.6 | 34.17 | 23.78 | 65.7 | 34.17 | 23.83 | 65.9 | 34.17 | 23.88 | 66.0 | 34.17 | 23.94 | 66.1 | 34.17 | 23.99 | 66.3 | 34.17 | 24.04 | 66.4 | 34.17 | 24.09 | 66.6 | 34.17 | 24.14 | 66.7 | 34.17 | 24.19 | 66.9 | 34.17 | 24.24 | | | | | | |
| 12.00 | 65.6 | 34.20 | 23.75 | 65.7 | 34.20 | 23.80 | 65.9 | 34.20 | 23.85 | 66.0 | 34.20 | 23.91 | 66.2 | 34.20 | 23.96 | 66.3 | 34.20 | 24.01 | 66.5 | 34.20 | 24.06 | 66.6 | 34.20 | 24.11 | 66.8 | 34.20 | 24.16 | 66.9 | 34.20 | 24.21 | | | | | | |
| 12.10 | 65.6 | 34.24 | 23.72 | 65.8 | 34.24 | 23.77 | 65.9 | 34.24 | 23.82 | 66.1 | 34.24 | 23.88 | 66.2 | 34.24 | 23.93 | 66.3 | 34.24 | 23.98 | 66.5 | 34.24 | 24.03 | 66.6 | 34.24 | 24.08 | 66.8 | 34.24 | 24.13 | 66.9 | 34.24 | 24.18 | | | | | | |
| 12.30 | 65.7 | 34.32 | 23.66 | 65.8 | 34.32 | 23.71 | 66.0 | 34.32 | 23.76 | 66.1 | 34.32 | 23.82 | 66.3 | 34.32 | 23.87 | 66.4 | 34.32 | 23.92 | 66.5 | 34.32 | 23.97 | 66.7 | 34.32 | 24.02 | 66.8 | 34.32 | 24.07 | 67.0 | 34.32 | 24.12 | | | | | | |
| 12.30 | 65.7 | 34.32 | 23.66 | 65.8 | 34.32 | 23.71 | 66.0 | 34.32 | 23.76 | 66.1 | 34.32 | 23.82 | 66.3 | 34.32 | 23.87 | 66.4 | 34.32 | 23.92 | 66.5 | 34.32 | 23.97 | 66.7 | 34.32 | 24.02 | 66.8 | 34.32 | 24.07 | 67.0 | 34.32 | 24.12 | | | | | | |
| 12.40 | 65.7 | 34.36 | 23.63 | 65.8 | 34.36 | 23.68 | 66.0 | 34.36 | 23.73 | 66.1 | 34.36 | 23.79 | 66.3 | 34.36 | 23.84 | 66.4 | 34.36 | 23.89 | 66.6 | 34.36 | 23.94 | 66.7 | 34.36 | 23.99 | 66.9 | 34.36 | 24.04 | 67.0 | 34.36 | 24.09 | | | | | | |
| 12.50 | 65.7 | 34.40 | 23.60 | 65.9 | 34.40 | 23.65 | 66.0 | 34.40 | 23.70 | 66.2 | 34.40 | 23.75 | 66.3 | 34.40 | 23.81 | 66.5 | 34.40 | 23.86 | 66.6 | 34.40 | 23.91 | 66.7 | 34.40 | 23.96 | 66.9 | 34.40 | 24.01 | 67.0 | 34.40 | 24.06 | | | | | | |
| 12.60 | 65.7 | 34.44 | 23.57 | 65.9 | 34.44 | 23.62 | 66.0 | 34.44 | 23.67 | 66.2 | 34.44 | 23.72 | 66.3 | 34.44 | 23.78 | 66.5 | 34.44 | 23.83 | 66.6 | 34.44 | 23.88 | 66.8 | 34.44 | 23.93 | 66.9 | 34.44 | 23.98 | 67.1 | 34.44 | 24.03 | | | | | | |
| 12.70 | 65.8 | 34.48 | 23.54 | 65.9 | 34.48 | 23.59 | 66.1 | 34.48 | 23.64 | 66.2 | 34.48 | 23.69 | 66.4 | 34.48 | 23.75 | 66.5 | 34.48 | 23.80 | 66.7 | 34.48 | 23.85 | 66.8 | 34.48 | 23.90 | 66.9 | 34.48 | 23.95 | 67.1 | 34.48 | 24.00 | | | | | | |
| 12.80 | 65.8 | 34.52 | 23.51 | 65.9 | 34.52 | 23.56 | 66.1 | 34.52 | 23.61 | 66.2 | 34.52 | 23.66 | 66.4 | 34.52 | 23.72 | 66.5 | 34.52 | 23.77 | 66.7 | 34.52 | 23.82 | 66.8 | 34.52 | 23.87 | 67.0 | 34.52 | 23.92 | 67.1 | 34.52 | 23.97 | | | | | | |
| 12.90 | 65.8 | 34.56 | 23.48 | 66.0 | 34.56 | 23.53 | 66.1 | 34.56 | 23.58 | 66.3 | 34.56 | 23.63 | 66.4 | 34.56 | 23.68 | 66.6 | 34.56 | 23.74 | 66.7 | 34.56 | 23.79 | 66.9 | 34.56 | 23.84 | 67.0 | 34.56 | 23.89 | 67.1 | 34.56 | 23.94 | | | | | | |
| 13.00 | 65.8 | 34.60 | 23.45 | 66.0 | 34.60 | 23.50 | 66.1 | 34.60 | 23.55 | 66.3 | 34.60 | 23.60 | 66.4 | 34.60 | 23.65 | 66.6 | 34.60 | 23.71 | 66.7 | 34.60 | 23.76 | 66.9 | 34.60 | 23.81 | 67.0 | 34.60 | 23.86 | 67.2 | 34.60 | 23.91 | | | | | | |
| 13.10 | 65.9 | 34.64 | 23.42 | 66.0 | 34.64 | 23.47 | 66.2 | 34.64 | 23.52 | 66.3 | 34.64 | 23.57 | 66.5 | 34.64 | 23.62 | 66.6 | 34.64 | 23.68 | 66.8 | 34.64 | 23.73 | 66.9 | 34.64 | 23.78 | 67.1 | 34.64 | 23.83 | 67.2 | 34.64 | 23.88 | | | | | | |
| 13.20 | 65.9 | 34.68 | 23.39 | 66.0 | 34.68 | 23.44 | 66.2 | 34.68 | 23.49 | 66.3 | 34.68 | 23.54 | 66.5 | 34.68 | 23.59 | 66.6 | 34.68 | 23.65 | 66.8 | 34.68 | 23.70 | 66.9 | 34.68 | 23.75 | 67.1 | 34.68 | 23.80 | 67.2 | 34.68 | 23.85 | | | | | | |
| 13.30 | 65.9 | 34.72 | 23.35 | 66.1 | 34.72 | 23.41 | 66.2 | 34.72 | 23.46 | 66.4 | 34.72 | 23.51 | 66.5 | 34.72 | 23.56 | 66.7 | 34.72 | 23.61 | 66.8 | 34.72 | 23.67 | 67.0 | 34.72 | 23.72 | 67.1 | 34.72 | 23.77 | 67.3 | 34.72 | 23.82 | | | | | | |
| 13.40 | 65.9 | 34.76 | 23.32 | 66.1 | 34.76 | 23.38 | 66.2 | 34.76 | 23.43 | 66.4 | 34.76 | 23.48 | 66.5 | 34.76 | 23.53 | 66.7 | 34.76 | 23.58 | 66.8 | 34.76 | 23.64 | 67.0 | 34.76 | 23.69 | 67.1 | 34.76 | 23.74 | 67.3 | 34.76 | 23.79 | | | | | | |
| 13.50 | 66.0 | 34.80 | 23.29 | 66.1 | 34.80 | 23.34 | 66.3 | 34.80 | 23.40 | 66.4 | 34.80 | 23.45 | 66.6 | 34.80 | 23.50 | 66.7 | 34.80 | 23.55 | 66.9 | 34.80 | 23.60 | 67.0 | 34.80 | 23.66 | 67.2 | 34.80 | 23.71 | 67.3 | 34.80 | 23.76 | | | | | | |
| 13.60 | 66.0 | 34.84 | 23.26 | 66.1 | 34.84 | 23.31 | 66.3 | 34.84 | 23.37 | 66.4 | 34.84 | 23.42 | 66.6 | 34.84 | 23.47 | 66.7 | 34.84 | 23.52 | 66.9 | 34.84 | 23.57 | 67.0 | 34.84 | 23.63 | 67.2 | 34.84 | 23.68 | 67.3 | 34.84 | 23.73 | | | | | | |
| 13.70 | 66.0 | 34.88 | 23.23 | 66.2 | 34.88 | 23.28 | 66.3 | 34.88 | 23.33 | 66.5 | 34.88 | 23.39 | 66.6 | 34.88 | 23.44 | 66.8 | 34.88 | 23.49 | 66.9 | 34.88 | 23.54 | 67.1 | 34.88 | 23.60 | 67.2 | 34.88 | 23.65 | 67.4 | 34.88 | 23.70 | | | | | | |
| 13.80 | 66.0 | 34.92 | 23.20 | 66.2 | 34.92 | 23.25 | 66.3 | 34.92 | 23.30 | 66.5 | 34.92 | 23.36 | 66.6 | 34.92 | 23.41 | 66.8 | 34.92 | 23.46 | 66.9 | 34.92 | 23.51 | 67.1 | 34.92 | 23.56 | 67.2 | 34.92 | 23.62 | 67.4 | 34.92 | 23.67 | | | | | | |
| 13.90 | 66.1 | 34.96 | 23.17 | 66.2 | 34.96 | 23.22 | 66.4 | 34.96 | 23.27 | 66.5 | 34.96 | 23.32 | 66.7 | 34.96 | 23.38 | 66.8 | 34.96 | 23.43 | 67.0 | 34.96 | 23.48 | 67.1 | 34.96 | 23.53 | 67.3 | 34.96 | 23.59 | 67.4 | 34.96 | 23.64 | | | | | | |
| 14.00 | 66.1 | 35.00 | 23.14 | 66.3 | 35.00 | 23.19 | 66.4 | 35.00 | 23.24 | 66.6 | 35.00 | 23.29 | 66.7 | 35.00 | 23.35 | 66.9 | 35.00 | 23.40 | 67.0 | 35.00 | 23.45 | 67.2 | 35.00 | 23.50 | 67.3 | 35.00 | 23.56 | 67.5 | 35.00 | 23.61 | | | | | | |
| 14.10 | 66.1 | 35.04 | 23.10 | 66.3 | 35.04 | 23.16 | 66.4 | 35.04 | 23.21 | 66.6 | 35.04 | 23.26 | 66.7 | 35.04 | 23.31 | 66.9 | 35.04 | 23.37 | 67.0 | 35.04 | 23.42 | 67.2 | 35.04 | 23.47 | 67.3 | 35.04 | 23.52 | 67.5 | 35.04 | 23.58 | | | | | | |
| 14.20 | 66.2 | 35.08 | 23.07 | 66.3 | 35.08 | 23.12 | 66.5 | 35.08 | 23.18 | 66.6 | 35.08 | 23.23 | 66.8 | 35.08 | 23.28 | 66.9 | 35.08 | 23.33 | 67.1 | 35.08 | 23.39 | 67.2 | 35.08 | 23.44 | 67.4 | 35.08 | 23.49 | 67.5 | 35.08 | 23.55 | | | | | | |
| 14.30 | 66.2 | 35.12 | 23.04 | 66.3 | 35.12 | 23.09 | 66.5 | 35.12 | 23.15 | 66.6 | 35.12 | 23.20 | 66.8 | 35.12 | 23.25 | 66.9 | 35.12 | 23.30 | 67.1 | 35.12 | 23.36 | 67.2 | 35.12 | 23.41 | 67.4 | 35.12 | 23.46 | 67.5 | 35.12 | 23.51 | | | | | | |
| 14.40 | 66.2 | 35.16 | 23.01 | 66.4 | 35.16 | 23.06 | 66.5 | 35.16 | 23.11 | 66.7 | 35.16 | 23.17 | 66.8 | 35.16 | 23.22 | 67.0 | 35.16 | 23.27 | 67.1 | 35.16 | 23.32 | 67.3 | 35.16 | 23.38 | 67.4 | 35.16 | 23.43 | 67.6 | 35.16 | 23.48 | | | | | | |
| 14.50 | 66.2 | 35.20 | 22.98 | 66.4 | 35.20 | 23.03 | 66.5 | 35.20 | 23.08 | 66.7 | 35.20 | 23.13 | 66.8 | 35.20 | 23.19 | 67.0 | 35.20 | 23.24 | 67.1 | 35.20 | 23.29 | 67.3 | 35.20 | 23.35 | 67.4 | 35.20 | 23.40 | 67.6 | 35.20 | 23.45 | | | | | | |
| 14.60 | 66.3 | 35.25 | 22.94 | 66.4 | 35.25 | 23.00 | 66.6 | 35.25 | 23.05 | 66.7 | 35.25 | 23.10 | 66.9 | 35.25 | 23.16 | 67.0 | 35.25 | 23.21 | 67.2 | 35.25 | 23.26 | 67.3 | 35.25 | 23.31 | 67.5 | 35.25 | 23.37 | 67.6 | 35.25 | 23.42 | | | | | | |
| 14.70 | 66.3 | 35.29 | 22.91 | 66.4 | 35.29 | 22.97 | 66.6 | 35.29 | 23.02 | 66.7 | 35.29 | 23.07 | 66.9 | 35.29 | 23.12 | 67.0 | 35.29 | 23.18 | 67.2 | 35.29 | 23.23 | 67.3 | 35.29 | 23.28 | 67.5 | 35.29 | 23.34 | 67.6 | 35.29 | 23.39 | | | | | | |
| 14.80 | 66.3 | 35.33 | 22.88 | 66.5 | 35.33 | 22.93 | 66.6 | 35.33 | 22.99 | 66.8 | 35.33 | 23.04 | 66.9 | 35.33 | 23.09 | 67.1 | 35.33 | 23.15 | 67.2 | 35.33 | 23.20 | 67.4 | 35.33 | 23.25 | 67.5 | 35.33 | 23.30 | 67.7 | 35.33 | 23.36 | | | | | | |
| 14.90 | 66.3 | 35.37 | 22.85 | 66.5 | 35.37 | 22.90 | 66.6 | 35.37 | 22.95 | 66.8 | 35.37 | 23.01 | 66.9 | 35.37 | 23.06 | 67.1 | 35.37 | 23.11 | 67.2 | 35.37 | 23.17 | 67.4 | 35.37 | 23.22 | 67.6 | 35.37 | 23.27 | 67.7 | 35.37 | 23.33 | | | | | | |
| 15.00 | 66.4 | 35.41 | 22.82 | 66.5 | 35.41 | 22.87 | 66.7 | 35.41 | 22.92 | 66.8 | 35.41 | 22.98 | 67.0 | 35.41 | 23.03 | 67.1 | 35.41 | 23.08 | 67.3 | 35.41 | 23.13 | 67.4 | 35.41 | 23.19 | 67.6 | 35.41 | 23.24 | 67.7 | 35.41 | 23.29 | | | | | | |
| 15.10 | 66.4 | 35.45 | 22.78 | 66.5 | 35.45 | 22.84 | 66.7 | 35.45 | 22.89 | 66.8 | 35.45 | 22.94 | 67.0 | 35.45 | 23.00 | 67.2 | 35.45 | 23.05 | 67.3 | 35.45 | 23.10 | 67.5 | 35.45 | 23.16 | 67.6 | 35.45 | 23.21 | 67.8 | 35.45 | 23.26 | | | | | | |
| 15.20 | 66.4 | 35.50 | 22.75 | 66.6 | 35.50 | 22.80 | 66.7 | 35.50 | 22.86 | 66.9 | 35.50 | 22.91 | 67.0 | 35.50 | 22.96 | 67.2 | 35.50 | 23.02 | 67.3 | 35.50 | 23.07 | 67.5 | 35.50 | 23.12 | 67.6 | 35.50 | 23.18 | 67.8 | 35.50 | 23.23 | | | | | | |
| 15.30 | 66.4 | 35.54 | 22.72 | 66.6 | 35.54 | 22.77 | 66.7 | 35.54 | 22.83 | 66.9 | 35.54 | 22.88 | 67.1 | 35.54 | 22.93 | 67.2 | 35.54 | 22.99 | 67.4 | 35.54 | 23.04 | 67.5 | 35.54 | 23.09 | 67.7 | 35.54 | 23.15 | 67.8 | 35.54 | 23.20 | | | | | | |
| 15.40 | 66.5 | 35.58 | 22.69 | 66.6 | 35.58 | 22.74 | 66.8 | 35.58 | 22.79 | 66.9 | 35.58 | 22.85 | 67.1 | 35.58 | 22.90 | 67.2 | 35.58 | 22.95 | 67.4 | 35.58 | 23.01 | 67.5 | 35.58 | 23.06 | 67.7 | 35.58 | 23.11 | 67.8 | 35.58 | 23.17 | | | | | | |
| 15.50 | 66.5 | 35.62 | 22.65 | 66.7 | 35.62 | 22.71 | 66.8 | 35.62 | 22.76 | 67.0 | 35.62 | 22.81 | 67.1 | 35.62 | 22.87 | 67.3 | 35.62 | 22.92 | 67.4 | 35.62 | 22.97 | 67.6 | 35.62 | 23.03 | 67.7 | 35.62 | 23.08 | 67.9 | 35.62 | 23.13 | | | | | | |
| 15.60 | 66.5 | 35.66 | 22.62 | 66.7 | 35.66 | 22.67 | 66.8 | 35.66 | 22.73 | 67.0 | 35.66 | 22.78 | 67.1 | 35.66 | 22.83 | 67.3 | 35.66 | 22.89 | 67.4 | 35.66 | 22.94 | 67.6 | 35.66 | 23.00 | 67.7 | 35.66 | 23.05 | 67.9 | 35.66 | 23.10 | | | | | | |
| 15.70 | 66.6 | 35.71 | 22.59 | 66.7 | 35.71 | 22.64 | 66.9 | 35.71 | 22.70 | 67.0 | 35.71 | 22.75 | 67.2 | 35.71 | 22.80 | 67.3 | 35.71 | 22.86 | 67.5 | 35.71 | 22.91 | 67.6 | 35.71 | 22.96 | 67.8 | 35.71 | 23.02 | 67.9 | 35.71 | 23.07 | | | | | | |
| 15.80 | 66.6 | 35.75 | 22.56 | 66.7 | 35.75 | 22.61 | 66.9 | 35.75 | 22.66 | 67.0 | 35.75 | 22.72 | 67.2 | 35.75 | 22.77 | 67.3 | 35.75 | 22.82 | 67.5 | 35.75 | 22.88 | 67.7 | 35.75 | 22.93 | 67.8 | 35.75 | 22.98 | 68.0 | 35.75 | 23.04 | | | | | | |
| 15.90 | 66.6 | 35.79 | 22.52 | 66.8 | 35.79 | 22.58 | 66.9 | 35.79 | 22.63 | 67.1 | 35.79 | 22.68 | 67.2 | 35.79 | 22.74 | 67.4 | 35.79 | 22.79 | 67.5 | 35.79 | 22.84 | 67.7 | 35.79 | 22.90 | 67.8 | 35.79 | 22.95 | 68.0 | 35.79 | 23.01 | | | | | | |

Based on 14% mb: Absorption (%) = (% protien x 1.5) + 43.6; Sample weight (g) = (100 - 14) / (100 - % sample moisture) x 35.0; Water (ml) = (% Absorption x 35.0 / 100) + (35.0 - sample weight)

# APPENDIX IV

Reprint: 1972 Bakers Digest 46(2):32.

## A Ten Gram Mixograph for Determining and Predicting Functional Properties of Wheat Flours

*By K. F. Finney and M. D. Shogren*

# A Ten-Gram Mixograph for Determining and Predicting Functional Properties of Wheat Flours

**By Karl F. Finney and Merle D. Shogren**,
Kansas State University,
Manhattan, Kans.

***Reprinted from the April, 1972 issue of BAKERS DIGEST***
***Vol. 46, No. 2, pp. 32.35, 3842, 77.***
*Copyright© 1972, Bakers Digest*

# A Ten-Gram Mixograph for Determining and Predicting Functional Properties of Wheat Flours[1]

**By Karl F. Finney and Merle D. Shogren,[2]**
Kansas State University
Manhattan, Kans.

Miller and Johnson (1) have reviewed studies of wheat-flour researchers who found the Mixograph useful for measuring important mixing properties of 35-g samples of bread flours. More recently, Finney and Yamazaki (2) have emphasized the instrument's usefulness for determining important physical dough properties of early generation progenies of bread wheats and, in addition, have demonstrated that mixogram mixing time of wheat flour can be used to predict bread loaf volume, dough oxidation requirement, and breadmaking water absorption. This paper describes a Mixograph that is even more useful than the 35-g version—a new, mechanically-simple, highly-standardized 10-g Mixograph that (together with flour protein content) can be used to determine some and predict other important breadmaking properties. The paper also describes in detail how the 10-g Mixograph can be used to determine bread-baking absorption.

## Developmental

**Figure 1** shows and describes the 10-g Mixograph. Dimensions of bowl, planetaries, and pins are given in **Figure 2.**

### *Wheat Flours*

Five wheat flours, each containing 12.4 ±0.2 per cent protein, were used in developing and standardizing the 10-g instrument. Four were experimentally milled from pure varieties harvested at Manhattan, Kansas, in 1968. RBS-70A flour was milled from a composite of many varieties harvested at many locations throughout the Great Plains in 1969. Quivira-Tenmarq x Marquillo-Oro (C.l. 12995, No. 1), Shawnee (C.I. 14157, No. 2), and RBS-70A (No. 3) possessed good loaf-volume potentials and long, medium-long, and medium mixing requirements, respectively. KS501097 (No. 4) and KS501099 (No. 5) had poor loaf-volume potentials and short mixing requirements. Optimum bread-making and mixogram absorptions (as received moisture basis) of the five flours were 64.0, 62.5, 64.5, 64.0, and 66.5 per cent, respectively.

### *Diameter of Pins and Spring Wire*

For the 10-g Mixograph, it was necessary to reduce the diameter of planetary and bowl pins from 1/8 in. (used with the 35-g Mixograph) to 3/32 in. to allow sufficient operating space between pins. We found that springs made from 0.033 in. diameter wire desirably positioned the mixogram on its paper, irrespective of wheat variety or locale where grown.

### *Effect of Arm Weight And String Damping*

After completing the 10-g mixing head and bowl, together with a compatible spring and a relatively frictionfree recording system, we studied the effects of the string-spool-damping system and damping arm (392-g) of the original 35-g Mixograph on 10-g mixogram characteristics (**Figures 3** and **4**). Full damping (**Figure 3**) obviously was too much; limited damping gave improved (wider) mixograms; but no damping gave highly satisfactory mixograms of all five flours.

Decreasing the weight of damping arm from 392 to 219 g (**Figure 4**) further increased the curve width and differentiation. When the arm weight was reduced to only 70 g, we obtained mixograms that were wider than necessary and required excessive amounts of ink. Thus, reducing flour weight from 35 to 10 g did not jeopardize in any way the manifestation of inherent mixing properties.

Examining the data closely (particularly **Figure 4**) suggested that an arm weight of about 300 g would give desirable mixograms (considering curve width, ink required, and differentiation). Because the bowl-platform bearings of our converted 10-g instrument had been used previously to record several thousand 35-g mixograms, we allowed for differences in free-wheelingness within and between used and new 10-g instruments. A 10g Mixograph converted from a 35-g instrument would contain some used, moving parts; thus, a 200-g arm plus two 50-g movable weights on a calibrated center bar of the damping arm were adopted to permit standardization of all Mixographs (and yet have somewhat wider 10-g than 35-g mixograms). One or both weights can be either moved closer to the bowl or removed, depending on the mixogram width desired.

After reducing the weight of the 219-g damping arm to 200-g, we observed that the 10-g mixograms are fully equal in all respects to those from the 35-g instrument (**Figure 5**).

We have converted two 35-g Mixographs to 10-g instruments. To produce essentially identical mixograms from a given sample of wheat flour, one instrument requires two 50-g weights and the other only one weight at the extreme right on the calibrated center bar. Two 10-g Mixographs purchased by DeKalb Ag Research, Inc. of Wichita, Kansas, and the Western Wheat Quality Laboratory at Pullman, Washington, were calibrated in our laboratory; they were found to produce

mixograms essentially identical to those from our instruments when both 50-g. weights were at the extreme right on the calibrated center bar of the damping arm.

## Standardization

### *Bowl and Head Pins*

1. Exposed length of each bowl and planetary pin shall be 1 3/8 in.
2. Bowl and planetary pins shall be straight and shall be perpendicular to bottom of bowl and planetary surfaces, respectively.
3. When head is in operating position, clearance between tips of planetary pins and bottom of bowl shall be the minimum distance necessary to avoid contact (about 1/32 in.).
4. Space between: (a) each pair of planetary pins, 0.438 in., (b) each planetary pin (of a pair) and the straddled bowl pin, 0.172 in., (c) any two bowl pins, 0.664 in., (d) any pin and its bowl side at bowl bottom, 0.297 in.

### *Mixing Head*

1. Head shall revolve at 88 +2 r.p.m.
2. Stationary gear shall be adjusted so that the face of dough guard and the front and rear pins are parallel to front of Mixograph base casting when pins form an isosceles trapezoid.
3. Mixing head shall be centered over bowl by adjusting head-chassis bearings. Bearings should be adjusted so that head moves up and down freely.

### *Bowl Platform*

1. Bowl platform shall be level when centered on recording paper.
2. Bearings shall be fitted and lubricated with 10W plain oil so that platform appears to move with essentially no friction.
3. Slotted-spring-tension bar shall be parallel to and flush with rear edge of bowl platform. Distance between center of bowl platform and on-center of notch 12 of the slotted-spring-tension bar shall be 14.9 cm.

### *Pen Arm and Pen*

1. Pen arm shall be positioned on its supporting rod so that, when Leroy3 pen No. 4 (1 7/8 in. reservoir) is centered on paper, front and back of bowl platform are parallel to and equi-distant from bottom and top horizontal lines, respectively, of recording paper.
2. Damping-arm stops shall be adjusted so that pen starts on bottom line of recording paper and stops on top line.
3. The shortest distance between rear point of attachment of spring (front of support post) and on-center of setting 12, when damping arm is at origin (pen at bottom of recording paper), shall be 22.4 cm.
4. Pen arm shall move up and down freely and the counter balance on pen arm shall be adjusted to that arm (without pen) is approximately balanced and falls slowly when released 1 cm above paper and rises slowly when released 2 cm above paper.
5. When recording a mixogram, the weight on the paper approximately equals the weight of the pen plus ink (about 6 g.).

### *Spring*

1. Length of relaxed spring proper (between extremities of stubs, but without slothook or threaded tail), when lying in a horizontal position shall be about 22.0 cm.
2. Length of relaxed spring proper plus the slothook, when lying in a horizontal position, shall be 22.7 cm.
3. Length of spring proper, when hanging vertically, shall be 23.1 cm + the length that the relaxed spring proper is greater or less than 22.0 cm (1.1 cm longer than relaxed spring).
4. Extensibility of spring, hanging vertically, shall be 3.5 +0.1 cm/100 g when applying several weights of 50 to 250 g.
5. When installed, there shall be 1.1 cm between spring stub and fixed, threaded, mounting bracket. However, if total length of relaxed spring proper, lying in a horizontal position (item 1), is not 22.0 cm, adjust distance so that length of spring proper plus distance between spring stub and mounting bracket shall total 23.1 cm.
6. Slothook shall be in outermost position (slot 12) of spring-tension index bar.

## Damping

1. Damping arm (removable portion at right of bowl platform) shall weigh 200 g without the movable weights.
2. Two weights (50 g each with set-screw) usually shall be set at outermost position on calibrated center bar of damping arm.

### *General*

1. Width of curve is affected by location of adjustable weights, drag of pen, amount of absorption water, and free-wheelingness of bowl-platform bearings.
2. Position of mixogram on recording paper is determined by extensibility, length, and slot location of spring.
3. All bearing points should have a trace of play to permit free movement and should be lubricated lightly and regularly.
4. There should be a hole on the bottom of each Mixograph cabinet, directly under the bowl-platform bearings. If bowl platform does not appear to be essentially friction-free (after removing spring from slot), remove the nut (with a 3/4 in. socket wrench), thus allowing the bottom Timken3 bearing and brass spacer to be removed from the bottom of cabinet. Then the bowl platform can be removed from the top, together with the top Timken bearing. When assembling, both Timken bearings should be cleaned and oiled. Avoid excessive tightening of the 3/4-in. nut.
5. Do not force V-belt over pulleys. To remove belt, first remove rear pulley. V-belt should be positioned on both pulleys, when replacing rear pulley.
6. Do not raise mixing head by lifting on top plate. Top plate contains a plain bearing. Lift on underneath side of head chassis.

## Operating Conditions and Procedures

1. Room temperature should be maintained at 77° + 1 to 2°F (or other suitable constant temperature) 24 hours a day. Equipment, flour, and water shall be at equilibrium with room temperature.
2. Weigh first flour sample (10 g on 14 per cent moisture basis) on torsion-type balance to 0.01 g.
3. Transfer weighed flour to Mixograph bowl No. 1—i.e., first tap scoop-type balance pan with the wooden handle of a 0.5-in., rectangular, camel-hair brush; then carefully brush out the pan.
4. With a 5/8- X 5-in. tongue depressor (squared-off and beveled ends) at center of and perpendicular to bottom of bowl, move flour between and somewhat past any two bowl pins. Repeat movement between and somewhat past the other two pairs of pins, so that a hexagonal hole is created in the center of bowl. Then cover bowl with a watch glass to avoid moisture loss or uptake. At the appropriate time, add absorption water to the hole created in the floor.
5. Dispense absorption water, depending on flour requirement (uniform dough consistency), from an 8ml automatic pipette (graduated in tenths) into a 15-ml beaker (cover by surrounding with a 50-ml beaker until mixogram is to be run). However, preliminary absorption water should be dispensed and discarded to eliminate the error (in the first absorption) that otherwise would be introduced by wetting the wall of the 15-ml beaker. If inside diameter of pipette is 5.5 to 6.0 mm, graduations will be about 4 mm apart, so that water readily can be estimated to 0.05 ml (0.5 per cent absorption).
6. After adding water from 15-ml beaker to the hole in the flour, immediately place bowl in position on Mixograph and start recording mixogram. Another 0.5-in., camel-hair brush is used to brush back any flour particles that may splash on the flare of the bowl during first few seconds of mixing.
7. Starting each mixogram on a 1minute arc and running for a fixed time greatly facilitate comparing, evaluating, and neatly mounting a group of mixograms.
8. A Gra-Lab[3] timer is recommended for conveniently spacing and automatically stopping mixograms.
9. While the first mixogram (bowl No. 1) is being recorded, the second flour is weighed out and added to bowl No. 2; its absorption water is dispensed into the 15-ml beaker. Both bowl and 15-ml. beaker are kept covered (as previously described).
10. Fold repeatedly a 10- x 10 ½ in. paper hand towel into a 1 1/4- x 5 1/4-in. absorbent mat. Then unfold once into a 2 1/2 x 5 1/4-in. mat to be placed under the recording pen as soon as each mixogram is completed. Before starting each mixogram use mat to insure that ink is flowing freely from pen.
11. After first mixogram is completed (and absorbent mat is placed under pen), the recording-paper motor is run for one minute to give desired spacing between mixograms. During spacing, mixing head is raised so that dough can be removed from pins of mixing head and combined with contents of bowl No. 1; bowl and contents then are placed in sink and filled with water. Removing dough from planetaries and their pins is greatly facilitated by intermittently wetting another 5/8- X 5-in. tongue depressor (with squared-off and beveled ends, each with a pin-size, centered slot 1/8-in. long, in 100-ml water in 250-ml beaker) and applying to underneath surfaces of planetaries and around their pin junctions in short, scraping strokes. By the time the planetary surfaces are wetted excessively, practically all the dough will have slipped into the bowl. Any dough remaining on planetaries or pins can be removed quickly with a few more tongue-depressor wettings, each followed by scraping at the spots of adhering dough; thereafter, any traces of dough are removed with a small piece (about 6 x 12 in.) of wet, hard-surfaced, hand toweling.
12. Then place bowl No. 2 containing the second flour in position on the Mixograph, after adding absorption water, and start recording mixogram.
13. While the second mixogram (bowl No. 2) is being recorded, the third flour is weighed out, added to bowl No. 3, and the required absorption water dispensed into the 15-ml beaker (remember covers).
14. Then the bulk of dough in bowl No. 1 (in sink), after pouring off most excess water, is freed from the bottom of bowl and bottoms of pins with the wet, notched, tongue depressor. Thereafter, when the bowl is inverted over a sheet of paraffin-coated paper, practically all of the dough will drop from the bowl. Bowl No. 1 is then quickly washed under the tap with a few strokes of a wet test-tube brush (3/4-in. diameter). If brush is applied with a minimum of pressure in a stream of water, scratching of inside bowl surface will be avoided. Accumulated dough in brush can be removed readily by soaking in 225 ml. 0.01 M lactic acid in 250-ml Erlenmeyer flask.
15. After brushing and rinsing bowl No. 1 under the tap, dunk it in about 900 ml of distilled water (at room temperature), in a 2000-ml stainless steel beaker, to quickly bring the bowl temperature close to room temperature. Then quickly dry the bowl by rotating a towel-covered, 5/8 x 5 1/2-in. tongue depressor (arced ends) around its inside wall, followed by a finger-covered towel on the bottom-center of bowl and along pin surfaces facing each other and the center of bowl. Bowl No. 1 is now placed on table in back of bowl No. 3 containing the third flour sample. Thus, bowl No. 1 is allowed to further dry in the air for a few minutes prior to weighing out and adding the fourth flour sample. About 5 to 6 minutes of the mixogram of the second flour (in bowl No. 2) has been recorded by now.
16. Three numbered mixing bowls are required for an efficient routine of recording mixograms of wheat flours. As soon as the recording of each mixogram has begun, sample number, date bowl number, and other pertinent data are pencilled on the bottom, unlined strip of recording paper.
17. One-minute intervals between mixograms is desirable. After the last mixogram has been recorded, the recording-paper motor is allowed to run for 16 minutes so that, beyond the tail of the last mixogram, there are several arcs just outside the recording-paper opening on the

left side of the Mixograph cabinet. Cut paper three to four arcs beyond the tail of last mixogram.

18. After recording the last mixogram and cleaning planetaries and their pins, it is advisable to place a towel on the bowl platform and allow the mixing head to run simultaneously with the recording-paper motor. During that period, dough particles between the planetaries and their housing will dry and be dislodged onto the towel. Bowl platform must be kept free of flour or dough particles, which could raise the bowl sufficiently to permit contact between planetary pins and bowl bottom.
19. Each day of operation, two or three mixograms of a well-known standard flour should be recorded before other flours are tested. The standards will provide necessary warm-up of all parts of the Mixograph and also will give assurance that everything is in order. If the Mixograph is idle for extended periods during the day, the LeRoy pen No. 4 must be capped to prevent ink from drying in the pen opening; and one or two mixograms of the standard flour should be recorded prior to other recordings. Make sure pen is flowing freely before starting each mixogram. The pen must be cleaned at the end of each day's recordings.
20. Contrary to **Figure 1**, the recording paper should pass from the paper platform counterclockwise over the toothed, drive cylinder, then down and clockwise around the removable axle below the drive cylinder, and finally up and out the paper exit window. Two No. 5 medium binder clips, attached as weights on either side of the recording paper just outside the window, are moved up ward after each mixogram is completed.
21. Recording paper specifically designed for both the 10-g and 35-g instruments soon will be available.

## Application

### *Flour Protein Content*

Flour protein content (Kjeldahl nitrogen x 5.7) is extremely important because all other flour properties are in some way a function of protein quality. For example, flour water absorption is a linear function of protein content within a variety of wheat (3); mixing requirement, mixing tolerance, and dough handling characteristics within a variety are related to protein content; oxidation ($KbrO_3$) requirement, in general increases with protein content within a variety (2), and loaf volume is highly correlated with protein content within a variety (4).

Even bread-crumb grain is relatively heavy at the low, best at the medium, and undesirably open at the high protein levels. Thus, protein content must be known for proper and accurate evaluation of the important flour properties constituting baking quality. Flour moisture content must be determined so that flours may be weighed and protein contents compared on a constant-moisture basis.

### *Flour Water Absorption*

Working, or "as received," flour absorption is a function of protein content, variety, flour moisture, and environment. Preliminary baking absorption or mixogram absorption is determined with the aid of the data illustrated in **Figure 6**. Those data show that water absorption (14 per cent moisture basis) increases with increasing flour protein content within a variety (average of environments) and that the regression lines for different wheat varieties form a fanshaped family of lines. The vertical distance between any two regression lines represents a genetic difference in water absorption. Using this figure, absorption of an unknown can be adjusted to any suitable protein content for evaluating against absorptions of standard wheat varieties. The regression line to be used for an unknown is estimated from the regression lines of the parents. If the parents are not known, the approximate mean regression line represented by Tenmarq should be employed. Thereafter, estimated absorption on a 14 per cent moisture basis is readily adjusted for flour moisture content to give the "as received" absorption for the mixogram.

When a number of sister progenies (say 20) are involved, the composite effect of variety and environment can be determined accurately after 15 g of each are composited to give 300 g of flour for baking. During baking (100 g) the suitability of the estimated absorption level (from Tenmarq regression line, protein and moisture contents) can be ascertained. Thereafter the regression line representing the adjusted mean absorption of the sister progenies can be selected and applied to each sister.

For example, the composite of the 20 sister progenies has a moisture content of 12.2 per cent and a protein content of 13.0 per cent (14 per cent moisture basis). Then, 13.0 per cent protein on the Tenmarq (Tm) regression line corresponds to 63.0 per cent absorption; and 63.0 + (100 - 98.0) = 65.0 per cent "as received" estimated absorption of composite. On a 100 g basis, 98.0 g flour at 12.2 per cent moisture is equivalent to 100 g flour on a 14 per cent moisture basis. During baking, however, 65.0 per cent absorption was found to be 1.5 per cent stiff, so that 65.0 + 1.5 = 66.5 per cent "as received" adjusted absorption. Thus, 66.5 percent corresponds to 64.5 per cent absorption on a 14 per cent moisture basis; and 64.5 per cent of absorption and 13.0 per cent protein correspond to the Cheyenne (Cnn) minus 0.2 per cent regression line of **Figure 6**. Now the "as received" absorptions of all 20 progenies are determined from the Cnn—0.2 per cent regression line and their corresponding protein and moisture contents. In any event, selected absorptions seldom are far enough off to prevent reliable determination of mixogram mixing properties.

Absorption also can be determined on an individual flour or on a composite of sister progenies by a mixogram method not previously described. The method is illustrated by the mixograms in **Figures 7** and **8**. As shown, stiff doughs produce mixograms having relatively wild swings, the extent of which depends on the degree of dough stiffness; whereas, slack doughs produce unusually narrow mixograms that are characteristically swayback during the hydrating and developing periods prior to reaching the peak or point of minimum mobility. Narrowness of mixogram and extent of swaybackness are a function of the degree of slackness.

To apply the data in **Figures 7** and **8**, a flour mixogram should be run with an absorption estimated from the Tenmarq (Tm) regression line and corrected to the "as received" moisture of the flour, followed by a mixogram with an absorption adjusted for the degree of stiffness or slackness estimated from the appearance of the first mixogram. Only occasionally is it necessary to run more than two mixograms. That method is being applied successfully in our laboratory to adjust the estimated (from regression line) absorptions of individual as well as composites of wheat progenies. Adjusting the estimated absorption by the 100-g baking technique obviously is limited to composites of relatively large numbers of progenies, particularly when only about 100 g of each progeny is available for micromilling. Absorptions of short-mixing varieties may be either above or below the average. It is highly significant, however, that wheat varieties with medium-long mixing times almost invariably have above-average water absorptions. Thus, approximate water-absorption level can be predicted from contemplated mixing requirement, particularly when only the relatively strong progenies with medium-long times previously have been selected.

## *Mixing Requirement and Tolerance*

In addition to determining mixing time or requirement by observation and judgment during baking, mixing requirement and tolerance (two important baking properties of wheat flour) can he determined from the mixogram obtained on a Mixograph using 10 g of flour and water equivalent to a suitable absorption.

Typical mixograms of flours that vary in mixing requirement and tolerance are illustrated in **Figure 9**. As the dough develops, the decrease in dough mobility and increase in the pull on the pins revolving through the dough are recorded on paper marked off by arcs at one-minute intervals. Note that the point of minimum mobility or maximum plasticity corresponds to mixing requirement in minutes. Thereafter, as mechanical degradation increases, dough mobility increases; the curve slopes downward and tails off to varying degrees, depending on the rate of mechanical breakdown (mixing tolerance) of the gluten protein. Six to seven samples per hour can be run by a single operator.

Referring to the top left mixogram in **Figure 9**, mixing requirement is less than one minute and mixing tolerance is very poor. From left to right and top to bottom, mixing tolerance (slope of curve beyond the peak) increases as mixing time increases to four minutes, then remains constant with increasing mixing time. Mixing requirements of eight to 10 minutes (not shown) are accompanied by mixing tolerances similar or identical to those shown for the two bottom mixograms. It is particularly significant that optimum mixing tolerance is reached when mixing requirement approaches four minutes. Thus, selecting new progenies of wheat with mixing requirements appreciably greater than about four minutes would not give increased mixing tolerance, but could and in many instances would increase bakery production costs.

## *Protein Content and Mixogram Characteristics*

The protein level of all flours represented in **Figure 9** was about 13 per cent. The effect of flour protein content on mixogram mixing time and tolerance is illustrated in **Figure 10**. As shown, the mixing requirement of Pawnee wheat flour containing 7.5 per cent protein is much longer and mixing tolerance materially greater than those values of flours containing 11 to 13 per cent protein. Mixing time, in general, decreases as protein content increases to about 12 per cent, thereafter remaining approximately constant with flour protein increases. For flours having undesirably low protein--starch ratios, more time is required to produce a continuous phase of protein, and mixing tolerance usually appears to be much better than that for flours containing desirable levels of protein (about 12 per cent or more). Thus, a pseudo mixing time and tolerance characterize low-protein flour samples.

The effect of protein content on curve characteristics of Quivira-Tenmarq x Marquillo-Oro (**Figure 11**), a long-mixing flour, corroborates the data and conclusions for Pawnee. Note that for both varieties the height of the curve increases with increasing protein content.

If adverse weather or other unusual growing conditions prevailed, their mixing requirements and other mixogram characteristics usually would deviate from those values of the typical samples represented here.

## *Oxidation Requirement vs. Flour Protein and Mixing Requirement*

Oxidation (bromate) requirement increases, in general, with increasing flour protein content within Pawnee and Kaw wheats (**Figure 12**), and therefore is predictable. For example 13.5 percent protein flours of those two varieties would require 4 +1 mg and 2 +1 mg of bromate, respectively. Note that a 2-mg bromate requirement for both a 9.5 per cent protein Pawnee and a 13.5 per cent protein Kaw would be categorized as large for Pawnee and medium-small for Kaw. The relatively large deviations about the imaginary regression lines are partly accounted for by the variation in mixing requirement within a variety and the interrelation of mixing time and oxidation requirement (**Figure 13**).

Also, oxidation requirement decreases materially with increasing mixing time or requirement (**Figure 13**), reaching a minimum at about five minutes (thereafter being approximately constant). Thus, oxidation requirement can be predicted from a knowledge of mixing requirement and flour protein content.

Although the mean flour protein between groups of composite samples varied from only 12 to 13 per cent, the variation in protein within each group was about +1 per cent of the mean. Accordingly, at least part of the deviation about the imaginary regression is attributable to a total protein content variation of about 11 to 14 per cent.

## *Dough Handling Characteristics vs. Mixing Requirement*

A reasonably accurate index of relative dough stability, elasticity, buckiness, extensibility, and mixing tolerance can

be obtained from bake mixing time or mixogram mixing time (time to peak). For example, a dough having a short mixing time of 1.5 minutes almost invariably will be less stable, less elastic, and more extensible than a dough having a longer mixing time (2.5 to three minutes). In general, as mixing time increases, dough extensibility decreases, and dough stability, elasticity, and mixing tolerance increase. As dough-mixing time increases beyond four or five minutes, however, the usually normal and desirable degree of elasticity and extensibility disappears and the doughs become increasingly bucky. In addition, long mixing times often complicate the baking schedule and increase production costs. Thus, doughs having very short mixing times usually have a predominance of extensibility and insufficient elasticity for a stable dough; whereas doughs having unusually long mixing times generally are not extensible enough to be desirably elastic. Both very short and extremely long mixing times, therefore, are undesirable properties.

### *Loaf Volume and Mixing Requirement*

Loaf volume at the 13 per cent protein level (protein quality) increases as mixing time increases from 7/8 to about three minutes. (**Figure 14**). Beyond three minutes, loaf volume at 13 per cent protein is approximately constant with increasing mixing time. The lowest loaf volumes for mixing times greater than three minutes are considered to be barely satisfactory; the others, however, are good to excellent. Thus, mixing time (or requirement) obtained from the mixogram is a reliable index of loaf-volume potential or protein quality.

With the aid of standard wheat varieties of known mixing and other breadmaking properties, it is practical and desirable to predict property categories (**Table 1)**, rather than numerical values, of unknown wheat flours—that is, a small, medium, or large bromate requirement; weak, mellow, or strong physical dough properties; and poor, fair, or good loaf volume. A desirable feature of predicting categories is that they essentially are independent of protein content variations above about 12.0 per cent. Remember that an adjustment must be made in mixing requirement (time to peak) when flour protein content is below about 12.0 per cent (Figures 10 and 11). Mixing time should be decreased about 12 per cent for each per cent of protein below 12 per cent.

## Summary

Described is a new, mechanically simple, highly-standardized Mixograph for determining mixing requirement, mixing tolerance, and water absorption, and for predicting oxidation requirement, dough-handling characteristics, and loaf volume of 10-g samples of wheat flours of known protein content. Details are given on developing and standardizing the 10-g instrument, together with operating conditions and procedures for recording mixograms.

## Acknowledgements

The construction of the 10-g Mixograph was made possible by the interest and cooperation of the National Manufacturing Co., Lincoln, Nebraska. The dedicated efforts and superior machine work of Henry Holze and Vern Devigne of that company and the encouragement and suggestions of Robert Bequette and James Wilson of DeKalb Ag Research, Inc., Wichita, Kansas, are gratefully acknowledged.

## Literature Cited

(1) MILLER, BYRON S. AND JOHNSON, JOHN A. A review of methods for determining the quality of wheat and flour for breadmaking. *Kans. Agr. Expt. Sta. Bull No. 76.* ( April 1954) .

(2) FINNEY, K. F. AND YAMAZAKI, W. T. Quality of hard, soft, and durum wheats. In: Wheat and Wheat Improvement. Agronomy Monograph No. 13, chapter 14. American Society of Agronomy: Madison, Wis. (1967).

(3) FINNEY, K. F. Methods of estimating and the effect of variety and protein level on the baking absorption of flour. *Cereal Chem.* 22: 149 (1945).

(4) FINNEY, K. F. AND BARMORE, M. A. Loaf volume and protein content of hard winter and spring wheats. *Cereal Chem.* 25:291(1948).

## Footnotes:

[1]Cooperative investigations of the Plant Science Research Division, Agricultural Research Service, U.S. Department of Agriculture and the Kansas Agricultural Experiment Station, Manhattan. Contribution No. 779, Department of Grain Science and Industry, Kansas Agricultural Experiment Station, Manhattan 66502.

[2]Research Chemist and Research Cereal Technologist, respectively, Hard Winter Wheat Quality Laboratory, U.S. Department of Agriculture, Manhattan, Kansas 66502.

[3]Mention of a trademark name, proprietary product, or specific equipment does not constitute a guarantee or warranty by the U.S. Department of Agriculture and does not imply its approval to the exclusion of other product' that may also be suitable.

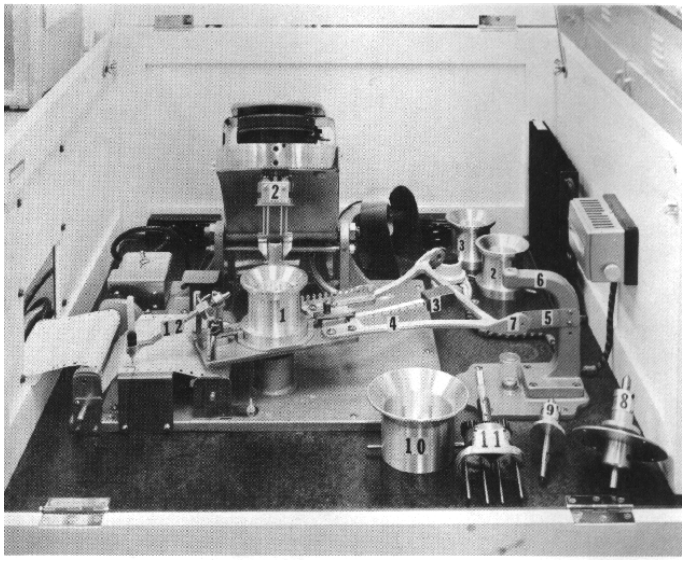


**Figure 1**: Mixograph for recording mixing properties of 10-g samples of wheat flours. Bowl No. 1I is in operating position, directly below the raised mixing head (No. 2) and its two planetaries, (each with two pins that revolve in a predetermined pattern about three stationary pins in the bowl). Disregard bowls No. 2 and 3 at back. The two 50-g movable weights (No. 3) are shown in their usual operating position on the calibrated scale of the damping arm (No. 4). Stop (No. 5) on either side of the chassis (No. 6) limit the forward and backward motion of the damping arm (No. 4) by contact with the damping-arm ears (No. 7). The detached string spools with (No. 8) and without (No. 9) the weighted disc (35-g Mixograph) used for full damping and limited damping are shown at right in front of the string-spool-damping chassis (No. 6). The 35-g Mixograph bowl (No. 10) and head (No. 11) are shown in the foreground for comparison. The pen arm (No. 12 without pen) is balanced and exerts no weight on paper. Screw-in pen with black drawing ink exerts about 6 g of pressure on the recording paper.

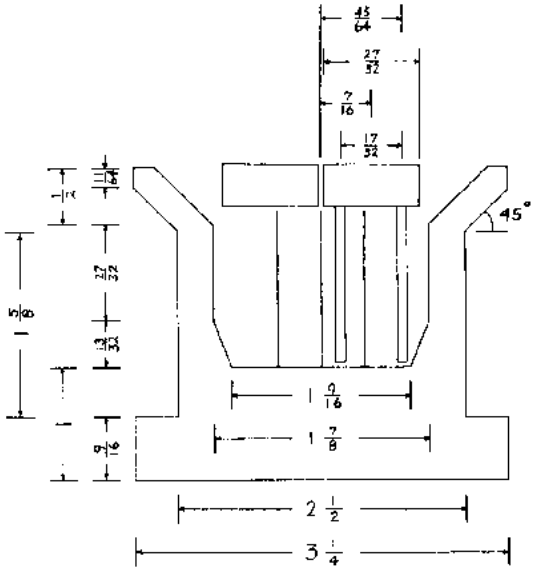



**Figure 2**: Dimensions of bowl, planetaries, pins, and related parts of the 10-g. Mixograph. The three 3/32 x 1-3/8 in. bowl pins define an equilateral triangle and are simply illustrated as lines perpendicular to bottom of bowl. The middle bowl pin actually is toward the front of bowl, and the two outside bowl pins are in a plane at back of bowl and parallel to front of mixograph (when pen is at center of recording paper). Thus, on-center distance between the two outside bowl pins (0.7577 in.) is the length of each side of the equilateral triangle defined by the three bowl pins. Other dimensions and details include (a) 45/64 in. is the distance between on-centers of stationary gear (not shown) and outside planetary pin, when on-centers of stationary gear ad planetary pins are on a straight line, (b) 27/32 in. is the diameter of each planetary, (c) 7/16 in. is the radius of the circle on which the three bowl pins, that define an equilateral triangle, are located, and also is the distance between on-centers of stationary and planetary gears (not shown), and (d) 17/32 in. is the distance between on-centers of each pair of planetary pins (only one pair shown), and (e) number of teeth on stationary and each planetary gear is 12 and 16, respectively. That ratio (3 to 4) determines the mixing pattern of the planetary pins.

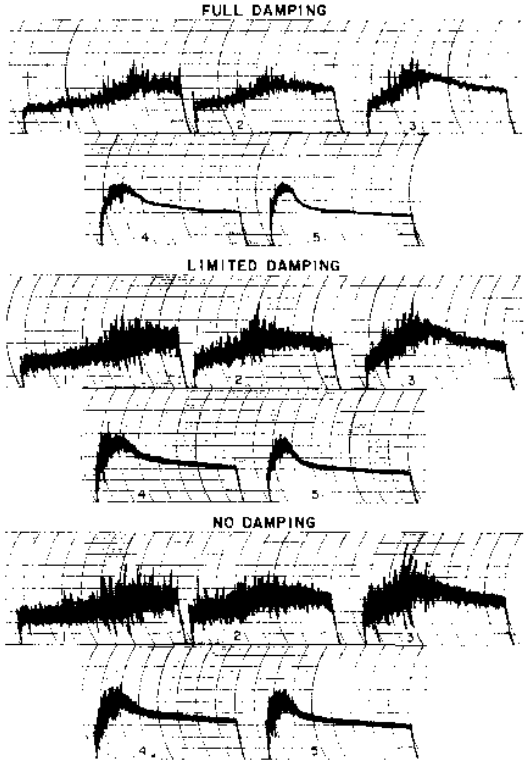



Figure 3: Effect of string spool with weighted disc (full damping), string spool without weighted disc (limited damping), and 392-g arm only (no damping) of the 35-g instrument on 10-g mixagram width. The 392-g arm was constant for all tests.

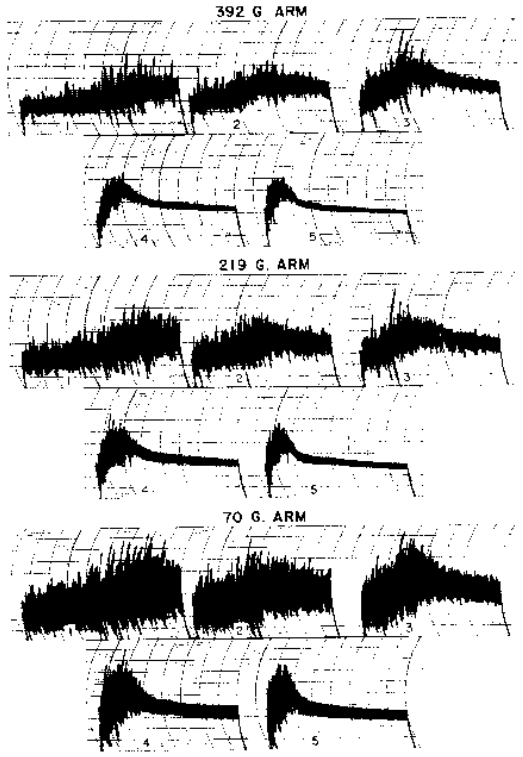



**Figure 4**: Effect of arm weight on 10g mixogram width

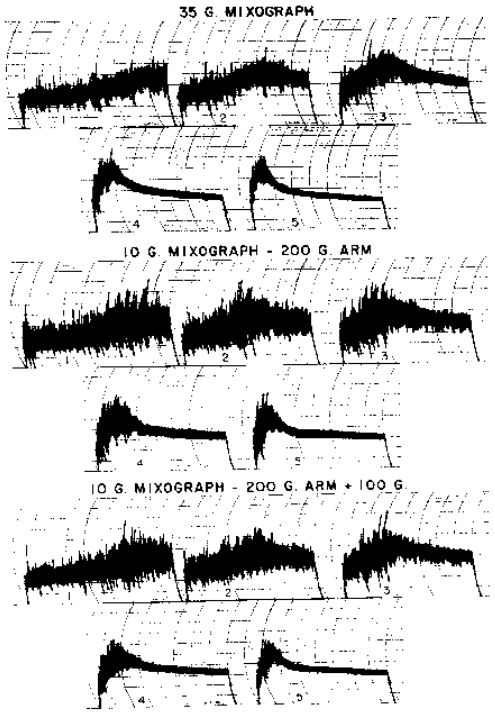



**Figure 5**: Typical mixograms obtained on the 10-g Mixograph (arm weights of 200 and 300 g) vs. the 35-g instrument.

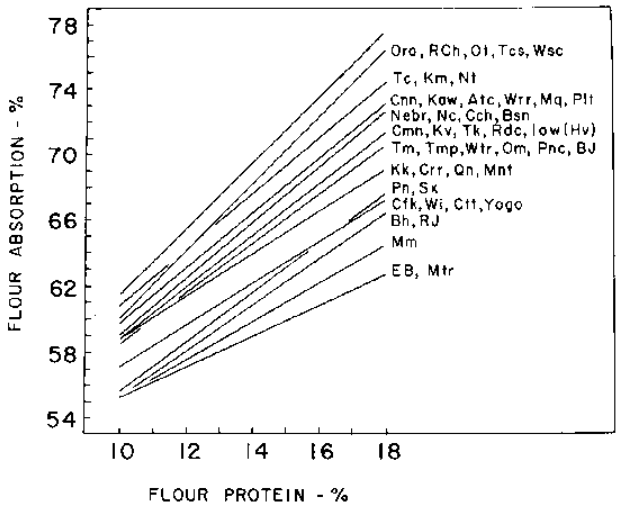



**Figure 6**: Flour absorption vs. protein content regression lines for 42 hard winter and three hard spring wheat varieties. Each variety regression line represents many samples harvested throughout the Great Plains during several crop years. Occasionally, an experimental progeny falls on the top line

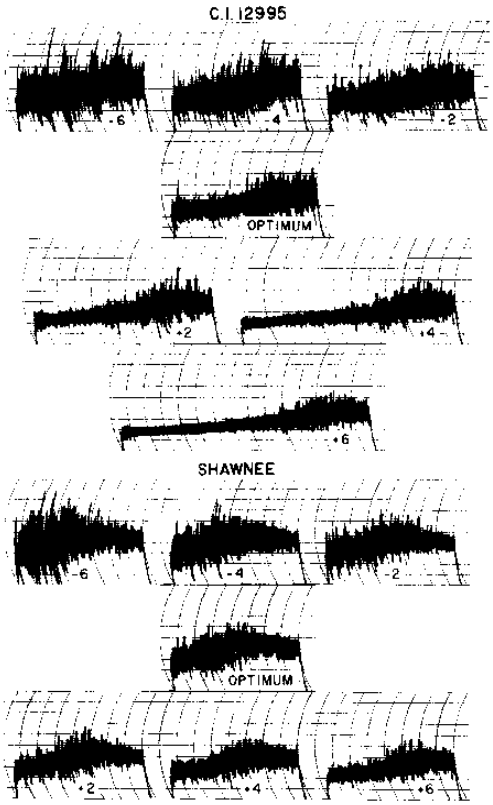



**Figure 7**: Effect of decreasing and increasing water absorption from optimum (negative and positive numbers, respectively, in percent) on 10-g mixogram characteristics of C.I. 12995; and Shawnee hard winter wheat flours.

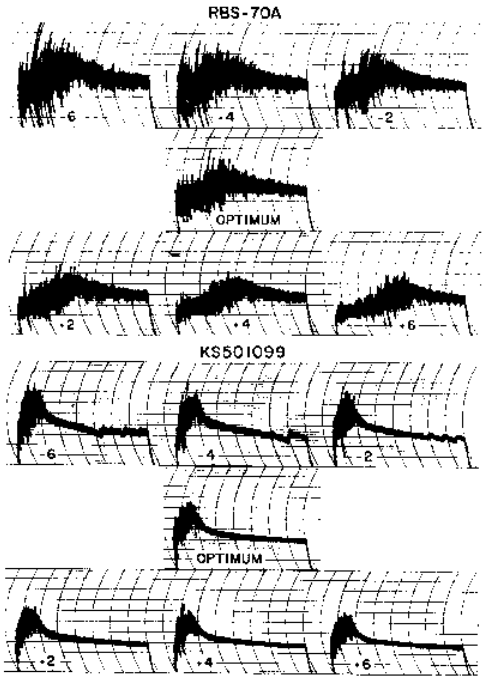



**Figure 8**: Effect of decreasing and increasing water absorption from optimum (negative and positive numbers, respectively, in percent) on 10-g mixogram characteristics of PBS-70A and KS501099 hard winter wheat flours.

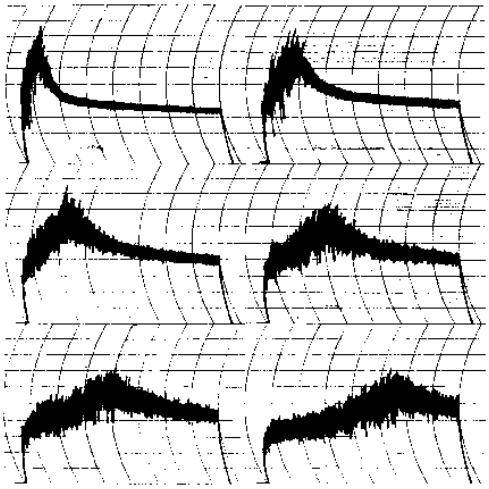


**Figure 9**: Typical mixograms of hard winter wheat flours that vary in mixing requirement (time to peak) and tolerance (slope and width after peak, and stability of mixogram height on either side of peak). Arcs are at one-minute intervals.

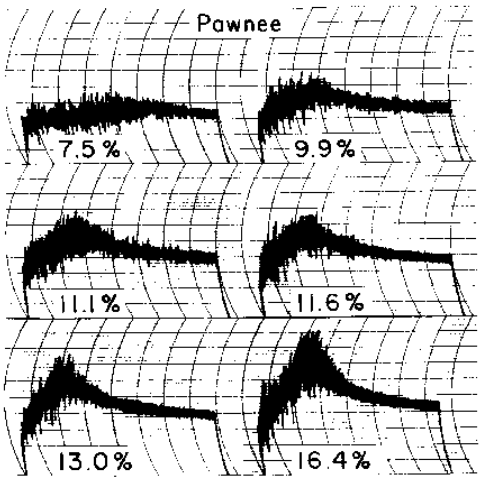



**Figure 10**: Effect of flour protein content on mixagram characteristics of Pawnee, a short-mixing hard winter wheat flour.

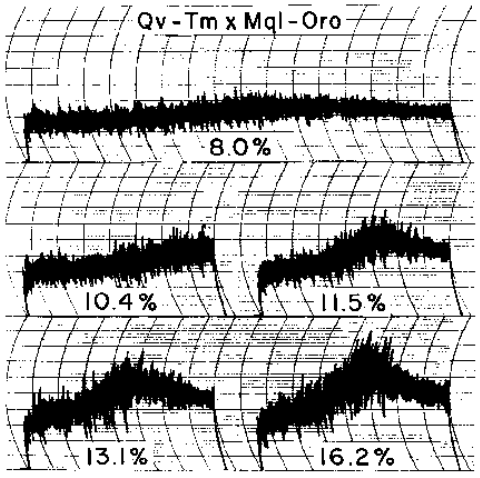



**Figure 11**: Effect of flour protein content on mixogram characteristics of Quivira-Tenmarq x Marquillo-Oro, a medium-long-mixing hard winter wheat flour.

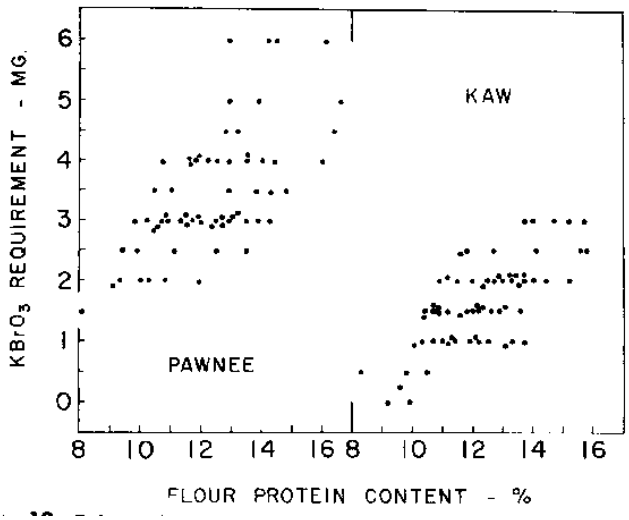



**Figure 12**: Relation between oxidation ($KBrO_3$) requirement and flour protein content of Pawnee and Kaw, short- and medium-long-mixing hard winter wheat flours, respectively. Samples were harvested throughout the Southern and Central Great Plains in 1959 to 1962.

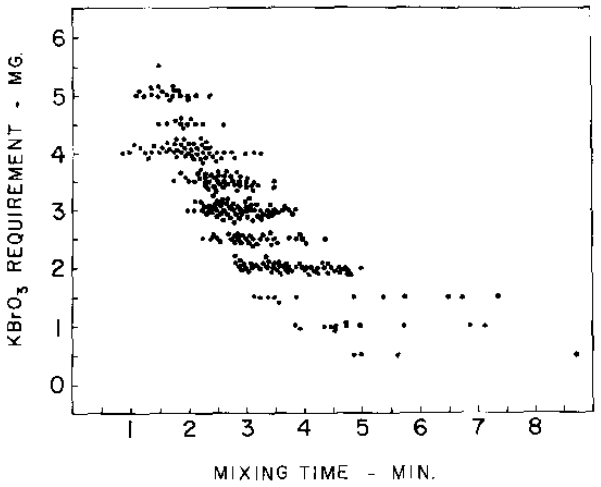



**Figure 13**: Relation between oxidation ($KBrO_3$) requirement and mixing time of hard winter wheat flour composites representing a relatively narrow range in protein content (1I to 14%) and a wide range in other baking quality (functional) characteristics. Variety composites were made up of hard winter wheats harvested throughout the Great Plains, 1959 to 1962.

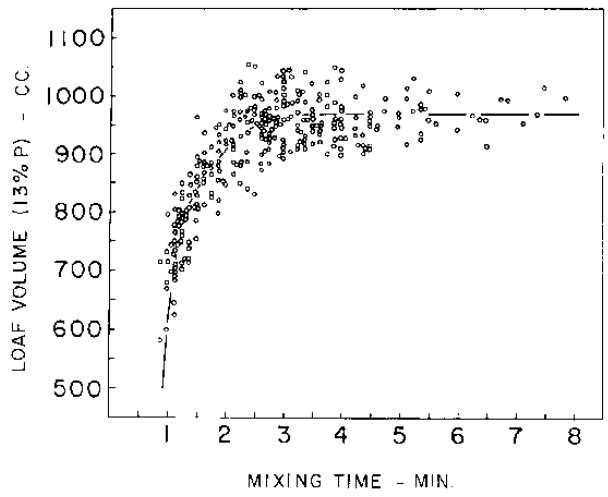



**Figure 14**: Relation between loaf volume at the 13% protein level (protein quality) and mixing time of hard winter wheat flours representing a wide range in baking quality characteristics. Samples with flour protein contents of about 11% and less were omitted to avoid their abnormally long mixing times. Wheat varieties
were harvested throughout the Southern and Central Great Plains in 1961 and 1962.

# Table 1

**Mixing Requirement and Related Predicatable Properties of Typical Wheat-flour Standards Useful in Categorizing Mixing and Other Breadmaking Properties of Unknown Wheat Flours**

| Wheat –flour Standards | Mixing Time min. | Properties Predictable From Mixing Time: Bromate Requirement | Physical Dough | Loaf Volume |
|---|---|---|---|---|
| C.I. 12995 | 5.5 to 7.5 (long) | Small | Very strong to bucky | Good |
| Shawnee | 4 to 5 (medium long) | Medium small | Strong | Good |
| RBS-70A | 3 to 3.5 (medium) | Medium | Mellow to medium strong | Good |
| Pawnee | 2 to 2.5 (short) | Medium large | Mellow | Poor to good |
| KS501099 | 1 to 1.5 (very short) | Large | Weak | very poor to fair |

# APPENDIX V

Reprint:  1994 National Notes 1(3):13.

Walt, the Story of National Manufacturing

*By P. J. Mattern*

# Walt, the Story of National Manufacturing

by P.J. Mattern[1]

[1]University of Nebraska, Department of Agronomy, Professor Emeritus and Retired Director of the Wheat Quality Laboratory, Lincoln, NE, USA.
Reprinted with permission from National Notes 1(3):13-14.

The story of Walton Cutler Ferris Sr. is also the story of the National Manufacturing Co. A 1915 graduate of the University of Nebraska's School of Agriculture, Walt became a major influence in the Cereal Technology community through his manufacture and promotion of several pieces of laboratory test equipment still used today, more than 50 years after their introduction. The author knew Walt personally and brings a unique flavor to this account.

Early information on Walt is sparse. He was born in 1896 at Solon, Michigan. In 1915 he graduated from the University of Nebraska School of Agriculture. Prof. Emeritus David McGill of the UNL Department of Agronomy has been monitoring the alumni records, etc., from this former school and he has the 1915 year book which I gave him. Walt was the art editor for that book. After graduation, Walt started teaching at the Northwest School of Agriculture in Crookston, MN. A Lincoln Journal article states he taught there until 1917.

According to his sister-in-law, Joy (the former Mrs. Peter Ferris), now Mrs. Guy Harris, Walt served in the Army Air Service. The Directory of Graduates of the University of Nebraska School of Agriculture (1932) lists graduates prior to 1920. Under World War I service, Walton C. Ferris was identified as a Second Lieutenant Supply Officer on duty at the Taliaferro Field, Texas, Aviation Corps. His brother, Peter was also in the military service and was stationed in the eastern U.S.

After November 11, 1918, Peter returned to Lincoln and worked for a Mr. Whitney who owned a company known as the National Manufacturing Company. Soon thereafter Walt also started working for the company. Pressure cookers were a main product.

Their foundry also made an automobile steering mechanism for a Nebraska distributor who re-sold it to a car manufacturer. In a personal discussion, Walt related how he borrowed money to purchase National Manufacturing. Jack Hoenig (a former general manager for Walt) recalls Walt's telling him how he improved this steering item. He patented a pressure cooker, but eventually stopped making pressure cookers because of liability worries.

A custodian in North Platte conceived the idea of a "walking lawn sprinkler" which would move automatically along a watering hose to water a large lawn area. Walt re-designed the sprinkler and started production in 1938. During the 1940's and 1950's, the National Manufacturing Company sold between 10,000 - 15,000 sprinklers each year, but sales slowed when competitors started to make similar products. In the 1960's, National Manufacturing started producing the Roto-Raker, a power lawn rake. Walt's nephew, John (Jack) Ferris, designed and perfected this unit, for manufacture by National.

**DEVELOPMENT OF LABORATORY EQUIPMENT**

Cereal Laboratory equipment was an important side line for many years. Ideas for equipment came from many cereal chemists. Prominent among them were C.O. Swanson and E.B. Working, Kansas State University; R.M. Sandstedt, University of Nebraska; and Karl Finney and Merle Shogren of the USDA, HRWW Quality Laboratory, Manhattan, KS.

Joy Harris believes the bread loaf volume meter was one of the first National products. In 1932, P.P. Merritt (later with Red Star Yeast) was working on a baking fellowship with R.M. Sandstedt to standardize the "pup" baking test for 100g (flour) test loaves. A number of styles of bread pans were tried over the next few years. Prof. Sandstedt used the "high form" pan. Karl Finney selected the "low form" which corresponded better to the shape of a commercial loaf and was superior for high-protein large-volume loaves when evaluating new strains in breeding programs.

An early product was the "pressure meter," first with mercury manometers and later with pressure gauges. Currently, the pressure containers are combined with transducers and computer companions. The pressure meter evaluates gas pressure from 10g of flour, 0.3g compressed yeast and 7ml water. The test is highly correlated with the amount of "damaged starch" in the flour.

Prof. Sandstedt's original pressure meter was a half-pint, glass, canning jar with a mercury manometer mounted on a Kerr-type lid. The cast aluminum container made by National used the readily available rubber sealing ring normally used for home canning, after removal of the finger grip protrusion.

Other equipment items included the 200g dough mixer; later a 100g dough mixer (developed with Karl Finney); fermentation cabinets; several models of test baking ovens, including a small reel design, and the Mixograph. Equipment for chemical determinations included a horizontal revolving oven for determining moisture in cereal products. A 30° C water bath heated with an electric light bulb and controlled by a mercury thermostat, along with a boiling water bath and a test tube holding rack, were items used to determine the diastatic activity ($\alpha$-amylase) in flour. National also produced a set of small dough sheeting rolls and a 3-roll molder suitable for pup loaves.

Swanson and Working (1926) of Kansas State University describe a dough mixer to which they tried to attach a recording device. By 1933 those KSU workers (Swanson and Working 1933) had succeeded in producing a recording dough mixer and they describe several attempts to achieve this. Ofelt and Sandstedt (1941) describe the mixer in their paper as a "National Micro-Recording Mixer." Their curves were called "Recording micro mixer curves".

Johnson and Swanson (1942) describe a National Swanson-Working recording dough mixer or mixograph (note the lower case--this work predated 'Mixograph' as a trademark, but popularized the term). The curves were later identified as Mixograms by the same KSU scientists (Swanson and Johnson 1943).

According to an interesting article by Shogren (1990), the original 400g unit was redesigned by Working into a recording dough mixer for 35g flour samples. By 1939, its construction was redesigned and refined by Walton Ferris and put into production. It was referred to as the National Swanson-Working micro recording dough mixer.

Henry Holze, a machinist, came to work at National on June 1, 1940. He took over the production of the Mixograph. Henry also worked on the walking sprinkler and produced V-Belt production forms for the Goodyear V-Belt Division of Lincoln, NE. At retirement in 1971, Henry turned over the production of the Mixograph to Vernon Devigne but continued to work part-time for a few months into 1972. Henry currently continues to run his home based engraving business at the age of eighty-eight.

Before Vernon retired several years later, Uwe Frankle was selected to train with him in about 1975-76 in order to be ready to take over the production of the Mixograph. Uwe continues to produce Mixographs for National at the present time.

The Mixograph continued with little change until Finney and Shogren (1972) designed a bowl and head, and researched the arm and spring sizes for 10g samples. Henry Holze helped develop the 10g unit (1972). Karl Finney (1989) also worked with Uwe Frankle to develop a 5 g unit. At that time, the arm and stops of the present 10g Mixograph design were developed. The 5g prototype is at the USDA Laboratory in Manhattan, KS. Karl was interested in a 1g unit, but plans were dropped when the Australians developed a successful 2g unit.

Dr. John A. Shellenberger (KSU) made the suggestion that an "Award of Recognition" be given to Walton C. Ferris for his lifetime of effort on behalf of cereal chemists. The award was approved and the AACC made the presentation at the annual meeting in New Orleans October 5-8, 1976. Walt was pictured holding the award that was given to him in recognition of, and appreciation for, his contributions to the design and development of Cereal Laboratory Equipment.

Walt preferred to keep his company small. He thought thirty employees was appropriate for his "hands on" management and he believed in making quality products. Walt did not believe in heavily advertising the National line of cereal laboratory equipment, however, believing that quality and scientific reputation were the best way to sell.

St. John's Military Academy of Salina, KS inherited the National Manufacturing Company following the death of Walton C. Ferris, August 30, 1983. A fire destroyed much of the main machine shop October 26, 1984. Not interested in rebuilding, the company was sold piecemeal at an auction April 11, 1985. TMCO of Lincoln, NE purchased the company name, the Cereal Laboratory Equipment Line, and the Walking Sprinkler Division and moved production to their present location at 507 "J" street.

Walt was active in many community organizations. They included the Rotary Club, Masons, Nebraska Society of Mayflower Descendants, American Legion, and St. Paul's Methodist Church. He was also the first registered Boy Scout Master in Lincoln, NE.

Walt always had his camera handy at meetings both local and national. At the National AACC meetings he exhibited his laboratory equipment and occasionally other equipment. I'm sure he will be remembered by contemporaries as "one of a kind" as he personally stopped at each banquet table, greeted his friends, took his pictures, and distributed his company's gifts.

REFERENCES

Swanson, C. O. and Working, E. B. 1926. Mechanical modification of dough to make it possible to bake bread with only the

fermentation in the pan. Cereal Chem. 3(2):65-83
Swanson, C. O. and Working, E. B. 1933. Testing the quality of flour by the recording dough mixer. Cereal Chem. 10(1):1-29.
Ofelt, C. W. and Sandstedt, R. M. 1941. Observations on the character of recording-dough-mixers curves on flours diluted with wheat starch. Cereal Chem. 18(4):435-442.
Johnson, J. A. and Swanson, C. O. 1942. The testing of wheat quality by recording dough mixer curves obtained from sifted wheat meals. Cereal Chem. 19(2):216-229.
Swanson, C. O. and Johnson, J. A. 1943. Description of mixograms. Cereal Chem. 20(1):39-42.
Shogren, M. D. 1990. A short history of the Mixograph. Cereal Foods World 35(5):480-482.
Finney, K. F. and Shogren, M. D. 1972. A ten gram Mixograph for determining and predicting functional properties of wheat flour. Bakers Digest 46(2):32-42, 77.
Finney, K. F. 1989. A five-gram Mixograph to determine and predict functional properties of wheat flours. Cereal Chem. 66(6):527-530.

ACKNOWLEDGMENTS
I would also like to thank Karl Finney, Bob Bequette and Bob Pudden for they contributed valuable information and insight.